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SPACE PHASE 3

The Commercial Era Dawns

Notable views of notable people on aerospace matters...

aerospace perspectives

Caspar W. Weinberger, *Secretary of Defense, writing in Defense '82, a publication of the Department of Defense:*
"We see disturbing evidence that (the Soviets) think they can fight and win a nuclear war. We do not share this perception; we know nuclear war is unwinnable. But we do not feel we can successfully deter attack from an adversary such as the USSR if we relieve them of the necessity of all defensive planning. To do so would erode our deterrent by announcing that under no circumstances would we ever use our weapons first.

"Recently it has been argued that we should adopt such a policy of 'no first use' of nuclear force in the defense of Europe. While this sounds plausible enough, it lessens the effectiveness of deterrence. We must remember that NATO has effectively prevented Soviet aggression against Europe. In no small part, this is because our policy makes clear to the Soviets the tremendous risks to them of aggression there. Also, a 'no first use' policy might imply that the first use of conventional force is somehow acceptable.

"We reject this entirely. And we do so because our policy is to *deter*—not to *encourage*—the first use of force against us."

General Jerome F. O'Malley, *Vice Chief of Staff, U.S. Air Force, speaking to the 1982 Air Force Association Convention in Washington, D.C.:*
"Increases in defense spending are not coming at the expense of social programs, however popular the myth.

"The Department of Health and Human Services, for example, had a 1982 budget increase of approximately $25 billion, and Medicare/Medicaid spending is up $7.5 billion. The Health and Human Services budget is larger than the total budget of any country in the world except the United States and the Soviet Union. The Health and Human Services budget has $67 billion more in 1982 outlays than does the Department of Defense. . .

"Social programs are necessary and important. But I believe Sir John Slessor put it exactly right when he said that the *greatest* human service the government can give to its people is to keep them alive and free. We must keep our priorities straight."

Robert J. Carlson, *executive vice president, United Technologies, in an address to the Financial Times/Royal Aeronautical Society Aerospace Conference in London:*
"It's been said that the U.S. government foots the bill for U.S. manufacturers; that the National Aeronautics and Space Administration provides the technology money; that the Defense Department pours money into developments that ultimately find their way into commercial programs.

"The truth is that military engines derive much of their technology from commercial engines, not vice versa. Naturally, there is some crossover. But the military wants flight-proven technology; it doesn't want to take any chances or assume many risks. It's in the competitive commercial arena—with its historic demand for improved productivity—that the innovations occur. This year alone, Pratt & Whitney will spend over $500 million on research and development directed at current and future products—over and above the funds provided by our government for military engine research and development."

Charles E. Lord, *vice president and vice chairman, Export-Import Bank of the United States, speaking to a meeting of Aerospace Industries Association's International Council in San Francisco, California:*
"The current situation and expected developments in the commercial jet market have serious implications for this industry's exporting potential and for Eximbank policy. Increasing foreign competition for sales through the 1980s implies an even tougher battle for American suppliers . . . demand for Eximbank support will climb dramatically.

"We believe that the policy we have followed during the last year—providing financial support for truly competitive cases while seeking eventual elimination of subsidies for commercial aircraft purchases—will continue to provide a sound and successful approach as demand increases and competition intensifies. We will continue to provide credit for sales that face the strongest foreign competition. We will consider extended repayment terms in selected cases so that annual debt service requirements may be comparable to lower rate, shorter term offers. We will use guarantees instead of loans when the competitive situation indicates that risk protection combined with private sector financing is adequate to win the sale. Most importantly, we will continue our negotiating efforts to take governments out of the business of subsidizing credits for commercial jet aircraft, and to complete these sales at market rates of interest and on market terms in the future."

Raymond Garcia, *president, Coalition for Employment Through Exports, Inc., testifying before the Subcommittee on International Trade, Investment and Monetary Policy of the Senate Committee on Finance and Urban Affairs:*
"In general, we are disappointed with the Export-Import Bank's activities over the past year. We recognize that Eximbank's management has sought to accommodate the Bank's policies to a reduced budget and a weakened financial condition. But in our judgment it overreacted and formulated policies that needlessly lost export sales to our competitors.

"For example: In the space of four months, Eximbank's board raised interest rates twice . . . a 37 percent combined increase. This put U.S. exporters at a distinct competitive disadvantage . . . New lending was targeted primarily to those projects facing the most intense foreign subsidized credit competition. Under this approach, Eximbank support generally was no longer available for sales to developed countries, for sales of old-generation aircraft, drilling rigs

and selected other equipment, and for lines of credit to foreign countries . . . The temporary policy was made permanent of providing direct credits for only up to 65 percent of the value of U.S. exports, while foreign competitors provide 80 to 85 percent coverage . . .

"These (and other) restrictive measures dampened demand for Eximbank assistance, diverted some projects to overseas affiliates of U.S. firms and caused others to be lost entirely, losing jobs and supplier sales in the United States . . .

"(Survey results for 1981 show) lost exports totaling over $1.5 billion and supporting over 46,000 jobs . . . These examples do not comprise a comprehensive inventory of all export transactions . . . They do not include the value of follow-on orders, orders for spare parts and the like given up once sales are lost, particularly on 'big ticket' items. These can be as great or greater than the initial sales and represent markets that may not be recaptured for a generation, if ever. The tragedy is that these sales and jobs need not have been lost at all, if only Eximbank had followed the Congressional mandate to provide export financing that is competitive with that which is offered by other governments."

Donald Segner, *Associate Administrator for Policy and International Aviation, Federal Aviation Administration, addressing the National Aeronautic Association's Aerospace II Symposium in Williamsburg, Virginia:*

"Rotary-wing aircraft represent the fastest growing segment ment of the aviation industry. Today, use of the helicopter in certain military, natural resource exploration and development, and public service applications is unparalleled. The rotorcraft industry now appears ready, if allowed to fully utilize its unique operating capabilities, to provide far greater public and user benefit, such as regularly scheduled transportation services. And advanced technological breakthroughs foreseen on the horizon could completely alter the shape of tomorrow's transportation systems.

"Notwithstanding these attributes, rotorcraft is probably the least understood segment of our aviation system. For far too long, its capabilities have not been fully appreciated by the public in general, nor fully accommodated into our air transportation system. Helicopters have been largely ignored or treated as another form of fixed-wing aircraft by many, including segments of the FAA.

"I (will not) suggest that the FAA can chart a specific course of action among its helicopter activities that would evoke the full concurrence and support from all in the aviation and rotorcraft community. What we do promise is a new commitment and dedicated effort to meeting rotorcraft's operational challenges by fully integrating helicopters into the National Airspace System; to supporting changes to the NAS and our regulations to employ rotorcraft's unique capabilities to the maximum extent possible, and to pursuing initiatives to maintain United States leadership in the rotorcraft industry. This will not be an empty promise."

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Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems.

Foster understanding of the aerospace industry's responsibilities in the space exploration program.

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade.

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

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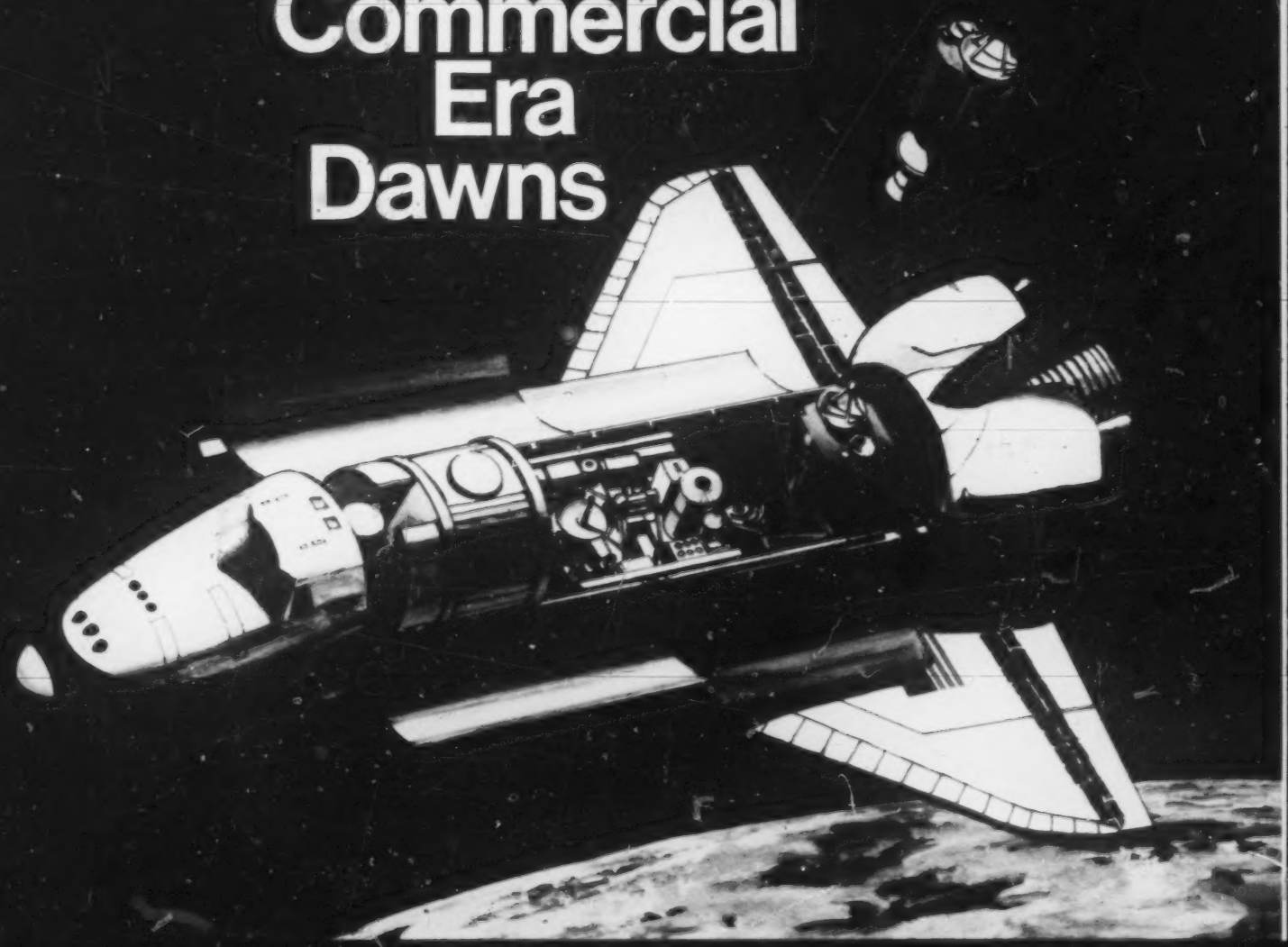
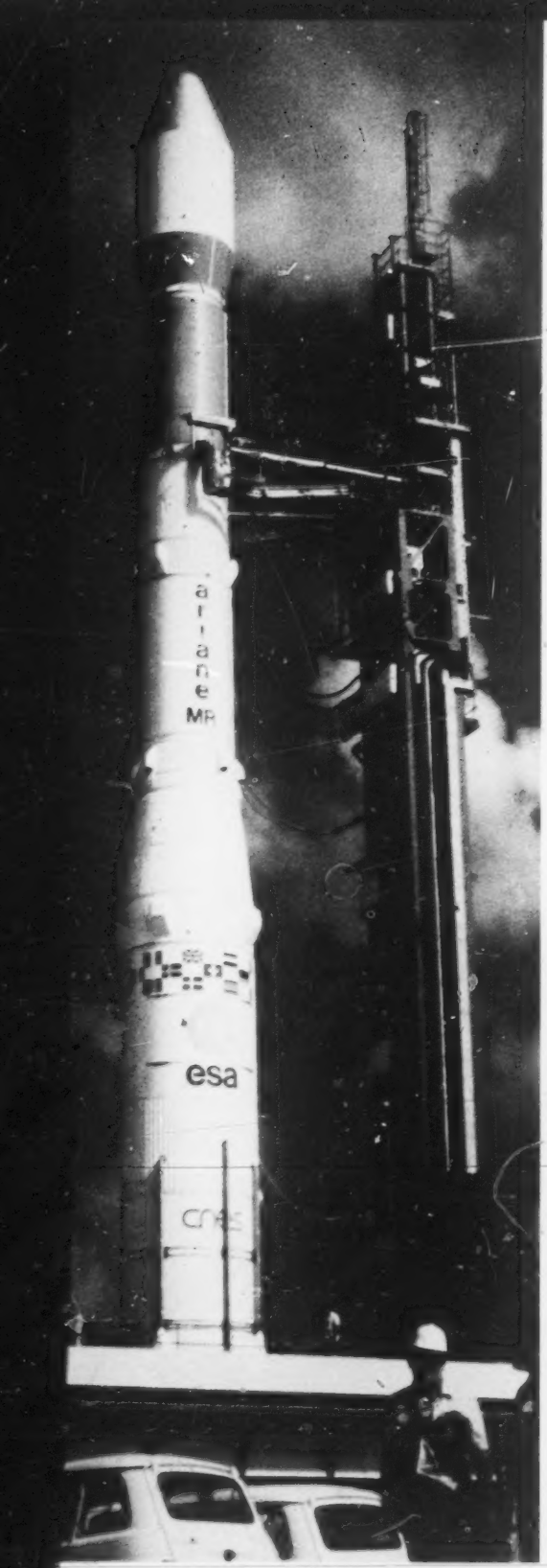
SPACE PHASE 3

Now operational, the Space Shuttle is attracting interest as a possible commercial vehicle. NASA has received proposals from several firms ready to invest private funds in space launch services

The Commercial Era Dawns





The Shuttle's principal competitor is the French-built three-stage expendable booster Ariane, shown in a test launch from Kourou, French Guiana. Managed by Arianespace, a European consortium, Ariane has had three successful flights in five launches.

By Robert F. Allnutt

Since 1980, there have been three developments of great importance to the future of space activities. In order of their potential impact, they are:

First, proof, through four successful flights, that the Space Shuttle concept works, and works well.

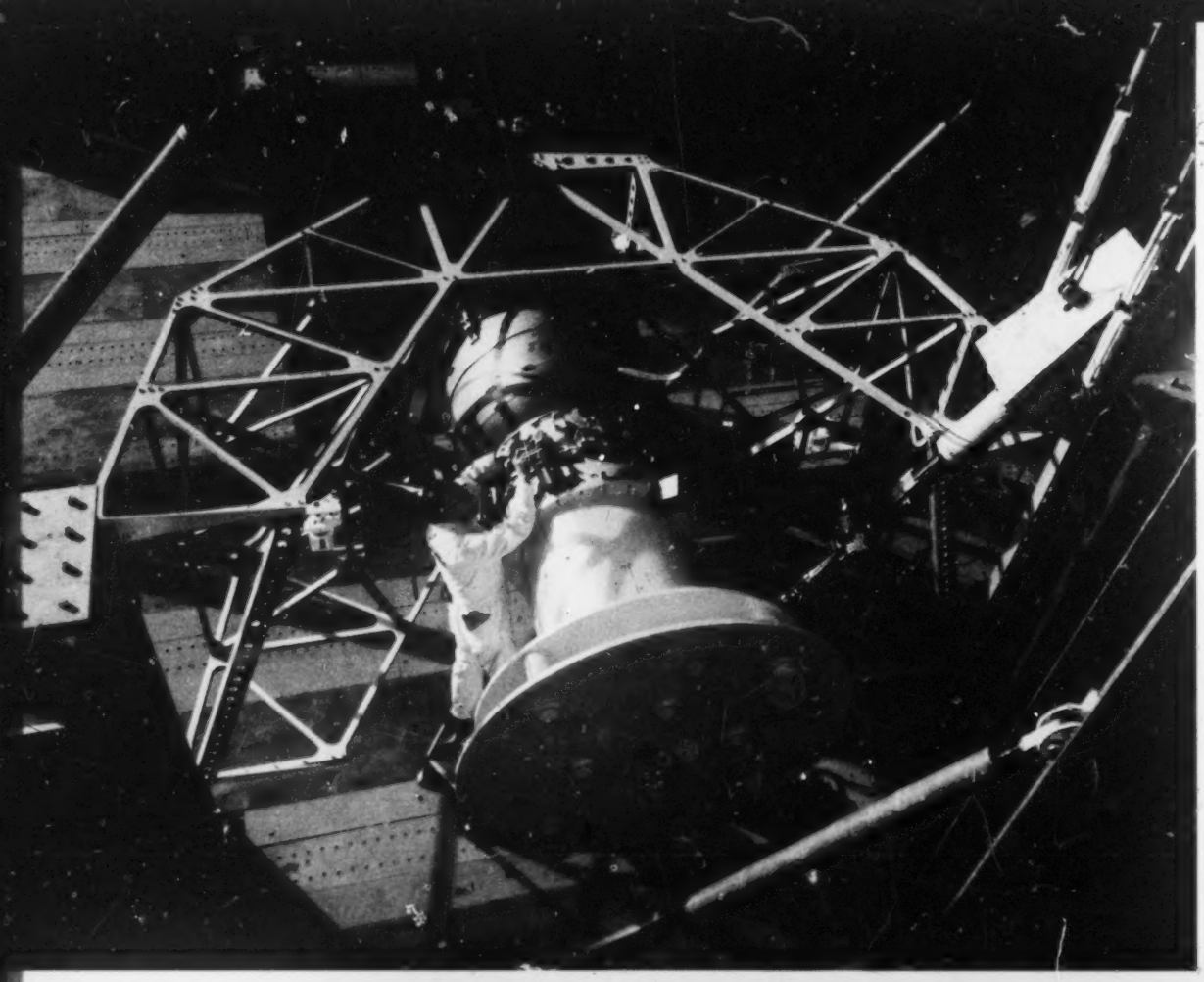
Second, a series of Soviet missions, including:

- **Orbital test of a winged, presumably reusable spacecraft; unmanned during this initial test flight, and much smaller than the Shuttle, the model was retrieved in the Indian Ocean by a seven-ship Soviet task force**
- **The final, 75-day mission aboard Salyut-6, completed in July 1981. During the life of this small space station, the Soviets demonstrated an emerging capability to construct and service modular stations in orbit.**
- **Launch last April of the improved Soviet space station Salyut 7. In June, a French-Soviet crew joined the prime crew for a week, marking the first participation by a non-Soviet bloc cosmonaut in Soviet manned flight activities.**
- **Reportedly the Soviets have resumed work on a very large booster, larger than the U.S. Saturn V of Apollo days, with obvious implications for their ability to place large structures in orbit.**

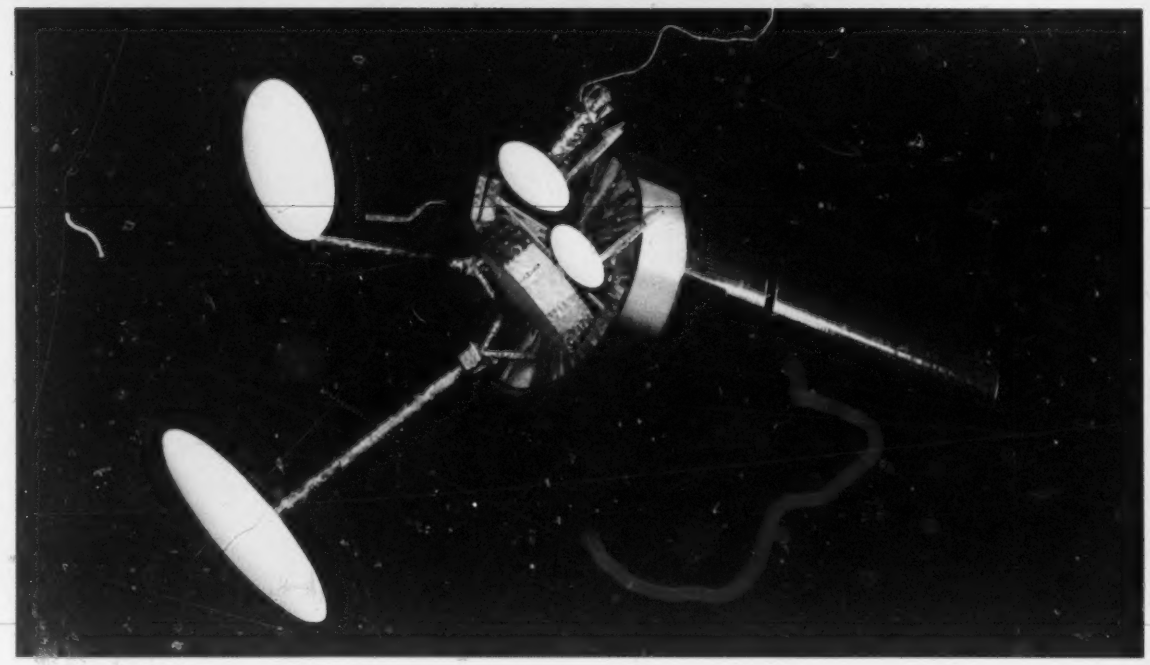
Robert F. Allnutt wears two hats at the National Aeronautics and Space Administration: he is Acting Associate Administrator for External Affairs and also Deputy General Counsel for Policy Review. He came to NASA in 1978 from the Department of Energy, where he had been Assistant General Counsel for Legislation. With degrees in both law and engineering, he has served since 1957 with a number of government agencies, including three prior tours at NASA. This article is adapted from his speech to the Financial Times Conference "Aerospace Enters a New Era" in London.

The third of these significant developments was the successful test of the European Space Agency's Ariane 1. This expendable launch vehicle brings to an end the U.S. monopoly in provision of launch services to the Western world. Arianespace, the quasi-governmental marketing firm established to sell launches on Ariane and planned larger variants, now counts 24 firm orders for launch services. An additional 13 launch reservations are confirmed by deposits of earnest money. In competition with U.S. expendable launch vehicles and the Space Shuttle, Ariane has won some Intelsat launches, one of two Arabsats, the first-generation Brazilian Domsat and launches for three U.S. firms—Southern Pacific Communications, GTE and Western Union. Within NASA, the stimulus of Ariane competition has given launch service marketing a long-overdue high profile. As a result, NASA won over Ariane in Colombia, and is quite competitive in current considerations in Mexico and Australia. We are learning that it is not enough simply to offer the best and least expensive service.

Each of these steps into space, and others that could be mentioned, have their importance. But it is the emergence of the Shuttle, after a decade of design and test, that signals something truly new for space-faring nations. For with the Shuttle and its progeny, we can look forward to far more routine use of space. With its hard vacuum and vanishingly small gravity, Earth orbit beckons in the age of Shuttle as an environment ready for profitable use,

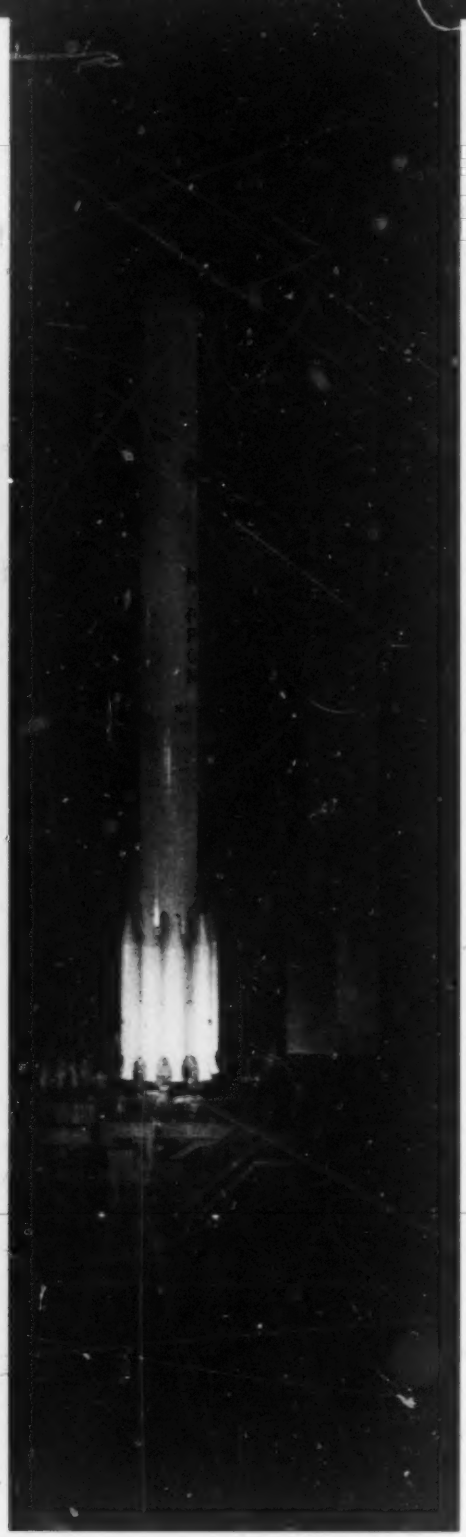


Shown being prepared for a structural test is the McDonnell Douglas Payload Assist Module (PAM), an upper stage system for delivering satellites to geostationary orbit (22,300 miles). Designed for use with the Space Shuttle or the Delta expendable launch vehicle, PAM was developed with private money as a commercial venture; the company has contracts for 27 missions.



Representative of the giant satellites being developed to meet surging capacity demand in space-based commercial communications is Hughes Aircraft Company's two-ton Intelsat VI, slated for first service in 1986. Note the absence of solar "wings;" the solar cells for electrical power cover the whole cylindrical casing of the satellite.

Latest entry in the launch vehicle competition is the Conestoga, privately developed by Space Services, Inc. The vehicle pictured is a suborbital test version successfully flown in September



A probable future competitor for international space launch business is Japan's National Space Development Agency (NASDA), whose N-type booster is pictured. NASDA has been testing launch vehicles since 1978 and is developing a larger booster for service in the mid-1980s.

not merely as a place to go to, or pass through, at great risk and expense.

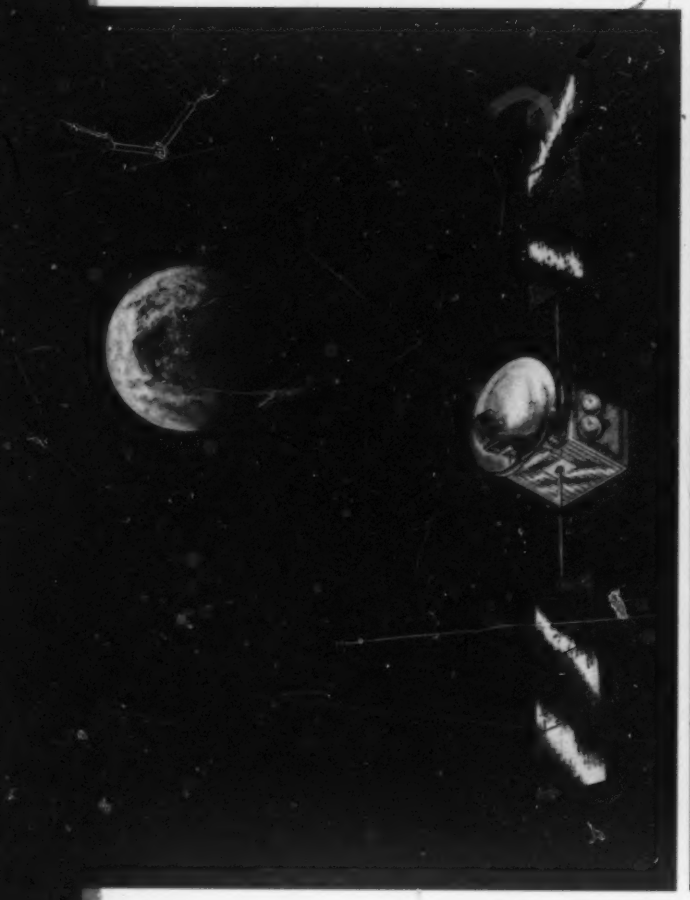
With this introduction, let me propound a theory. We stand today near the dawn of an era when commerce will become a far more significant factor among the three basic motivations for space programs in the Western world. The other motivations—exploration and national defense—will remain strong, with the defense missions prime among these two. However, commercial enterprise, including but not at all limited to telecommunications, will surge to the forefront.

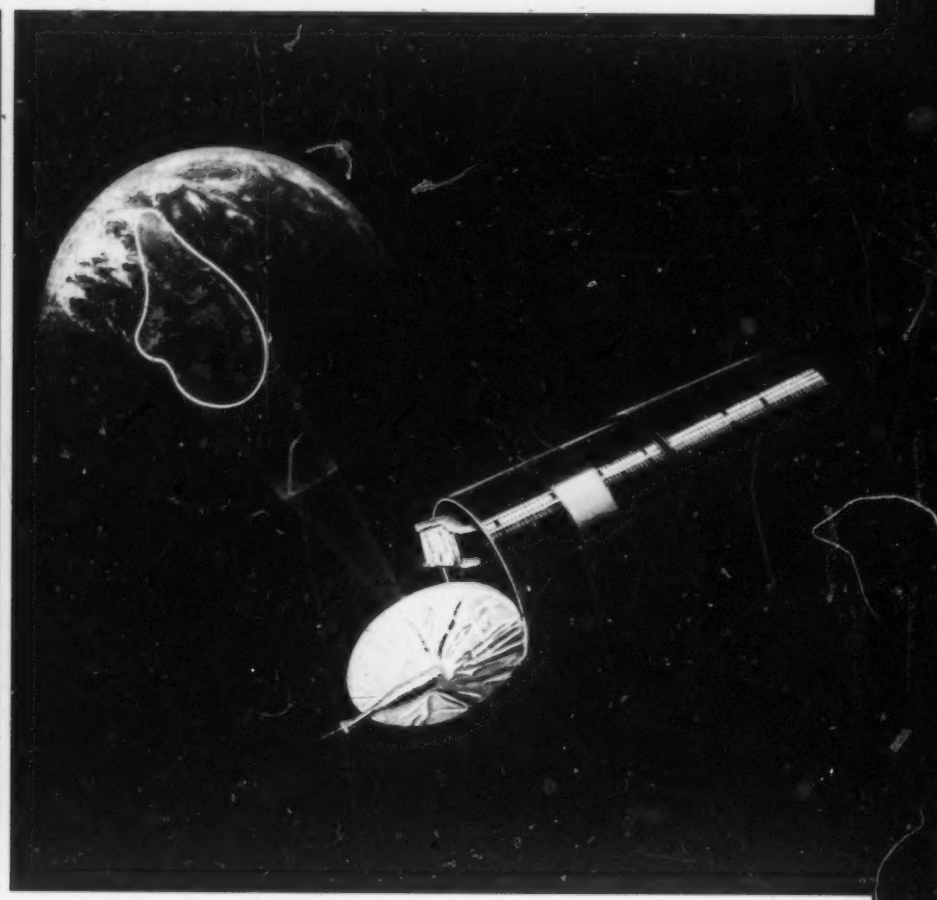
The basic concept underlying my theory is this: exploration (including scientific research), national security and commercial interests have each played major, often overlapping roles in spurring space efforts during the first quarter-century of the space age. During "Phase I," the period roughly bounded by Sputnik and Apollo, exploration was the major player, at least insofar as public opinion and popular support for space programs was concerned. We are now well into "Phase II," when concerns over the use and protection of space assets that support national security predominate. History teaches us that the twin drives of exploration and military purposes push back frontiers and foster great technological advances, but it is only when commercial motive becomes prominent that human activity truly prospers and enters periods of exponential growth in new regions. I believe that there are increasing signs that the period I call "Space Phase III" may be coming soon.

Space Stations

The existence of a space station would be of great import to the development of commercial enterprise in Earth orbit. The space station could serve as both a laboratory and a manufacturing/operations base. As a laboratory, the station would provide for extended observations of the land and oceans for those scientific, commercial, or security purposes where man's presence is important. The station also would enable man to participate in observations aimed in the opposite direction: outward to the Sun, the planets and the stars. Various material processing steps in small factories in or near a station would be monitored by the crew. As an operations base, the space station would provide for fueling and launch of orbitally-based propulsive stages, significantly increasing our capability to place satellites in geosynchronous orbit as well as to maneuver in low Earth orbit. The station also would serve as a construction base to assemble and erect large systems, such as antennas, imaging systems or other structures too large for launch directly from Earth. In addition, the space station would provide a base for the maintenance and servicing of free-flying unmanned satellites.

A space station, of course, is not a new idea. For nearly twenty years, NASA has





The commercial communications boom is spurring greater use of special area-coverage satellites. Developed by RCA Astro-Electronics, Satcom V (left) will be dedicated solely to Alaskan communications; it was launched in October. Built for the Indonesian government and scheduled for launch next year, Hughes Palapa B (right) will cover Indonesia, the Philippines, Malaysia, Singapore and Papua New Guinea.

examined the possibility of launching and operating a permanent, manned facility in low Earth orbit. During the course of many studies, various space station concepts have been considered. Skylab, one of NASA's most successful flight efforts, was a large, temporary space station.

Conceived at the height of the Apollo program, the Space Shuttle was inextricably linked to the concept of a space station; the Orbiters were intended to "shuttle" to and from an orbiting space station. Budgetary constraints forced NASA to choose between the space station and its Space Transportation System. Concluding that it made no sense to have a station in orbit without a reusable craft to service the facility, NASA decided to develop the Shuttle first, delaying the initiation of a space station. Interestingly enough, the Soviets, faced at about the same time with the same decision, chose the opposite approach.

Now it is appropriate to consider completing the original system. As our planning progresses, certain characteristics of the space station are known. The station will be launched and tended by the Shuttle. Communications will be through the Tracking and Data Relay Satellite System. At first the station is likely to be a relatively small facility, modular in nature, but the capability for expansion will be built in from the start. Finally, the architecture NASA adopts will include a role for man. The total system need not be manned, nor must each step in the evolution of the system include manned elements, but man is an essential element in any United States space station.

In a unique way, the European Space Agency (ESA) and the space agencies of Canada and Japan are partners in our study efforts. These agencies, having expressed an interest in the U.S. space station planning activity, are sponsoring space station mission analysis studies of their own. As these various studies are completed, we will share the results.

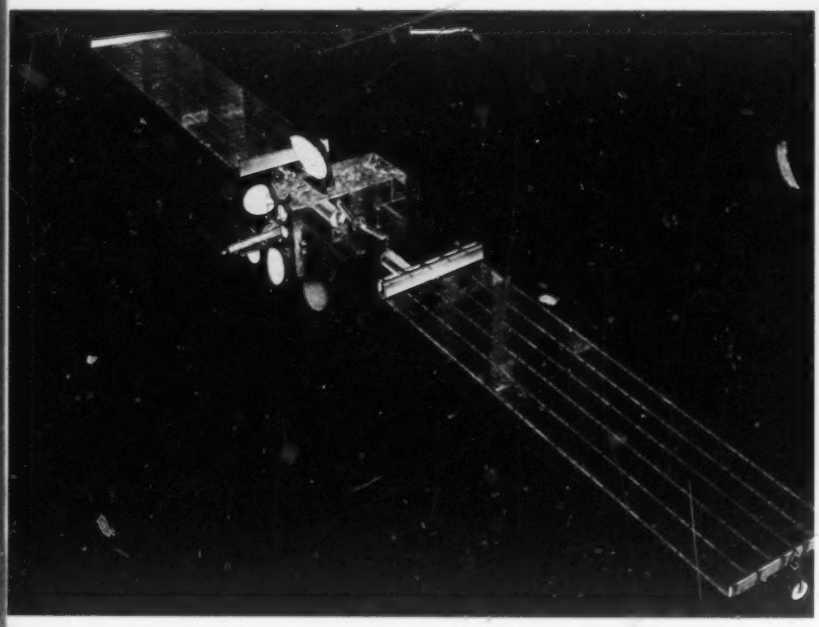
In the meantime, the Soviet Union seems clearly to have continued on course toward placing a large, permanent station in low earth orbit, most likely before a U.S. effort can reach the operation stage.

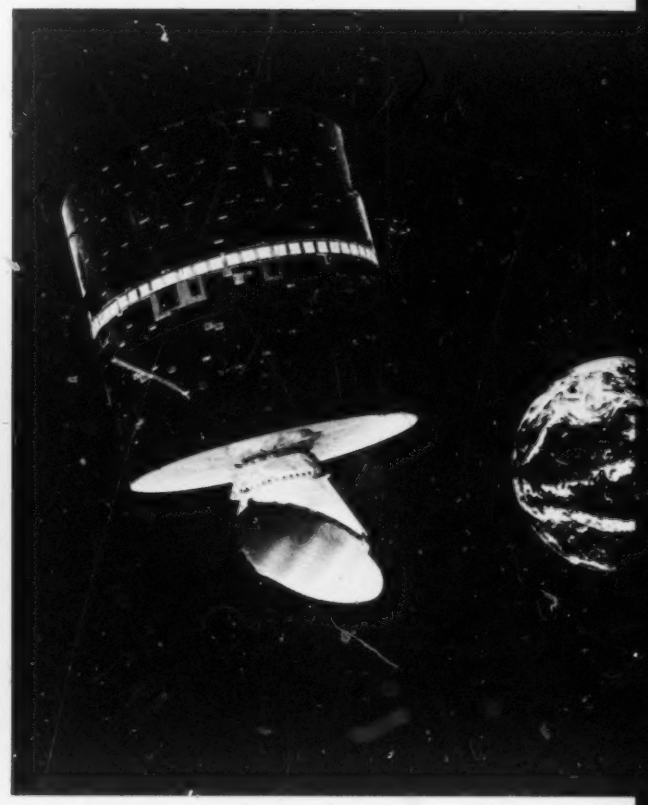
The Commercial Era

There is much evidence to support the notion of burgeoning commercial motivation and thus the approach of "Space Phase III." Let's examine some of that evidence.

I'll start from the ground up. Conservative estimates indicate that as many as 350 commercial communications satellites may be launched to geostationary orbit between now and the year 2000. Arianespace puts this figure near 200 for the 1980s alone. Some fraction of these satellites will be launched by expendable launch vehicles (ELVs) other than the U.S. Atlas Centaur, Titan and Delta. Ariane

European regional coverage will be provided by the L-Sat 1 pictured, which is among the largest and most powerful commercial satellites in development; the designation is short for Large Multi-purpose Satellite, meaning that it will relay a mix of TV, voice, business data and other communications. Scheduled for 1986 launch, L-Sat 1 is being developed for the European Space Agency (ESA) by British Aerospace, which is also developing ESA's medium-size European Communications Satellite, five of which will be launched between 1983 and 1986.





Japan's NASDA, which has been working on experimental comsats since the mid-seventies, launched the CS-1 Sakura in 1977 and plans to orbit an advanced operational satellite, designated CS-2, in 1983.

seems assured a small share of the market, and if Ariane succeeds, Japan, Inc., may not be far behind. Of late, the Soviets have also evidenced some interest in this business.

Nevertheless, the Shuttle will provide most of these launches. Thus, on their way to meeting with the Shuttle and U.S. ELVs, hundreds of these satellites will flow into the Kennedy launch center in Florida. To date, government facilities have been used to prepare these complex machines for mating with the launch vehicle. Private investment has now come into the picture. Increasingly, private facilities near the "Cape" will be used to prepare these communications satellites, and others, for launch.

How about the launch itself? Several proposals are currently pending before NASA for private investment in one aspect or another of launch services. One company has proposed purchasing a Shuttle Orbiter—an investment of over $1 billion—and entering the launch marketing business on the strength of this investment. A U.S. insurance company would be a major source of the investment capital.

At the same time, a United Kingdom firm is actively exploring investment of similar sums in some aspect of the Shuttle system. Several concerns have approached us with expendable launch vehicle or upper stage markets in mind. McDonnell Douglas currently builds at private risk the PAM upper stages used on Delta and in the Shuttle. A few months ago, a private firm approached NASA with the idea of underwriting the cost of modifying the Centaur high-energy upper stage for use in the Shuttle. Congress has since directed the first stage of this modification at public expense. However, the private firm remains interested in "Mark II."

Each of the U.S. expendable launch vehicle manufacturers continues to explore ways and means to produce, market and launch his rocket as a private venture. Several aerospace companies look to marketing launch services across-the-board. Finally, a private, Texas-based firm is developing a new launch capability.

So it seems clear, a quarter of a century into the space age, that the communications satellite business is thriving, and that rapidly increasing private investment in launch preparation and in launch itself is likely. But what of other potential commercial ventures in space?

In remote sensing, the U.S. Landsat is the only operational activity, but other nations—led by France and Japan, perhaps—are rushing to enter the market. For some time, the U.S. government has been exploring ways to turn this fruitful source of information into a commercial endeavor. Several companies have been successful in the value-adding business of interpreting the raw data, but the end-to-end business has not appeared feasible for private, unsubsidized ownership because of the high cost of the space

segment relative to the potential revenues from raw data sales. Many feel, however, that this picture will change as the worldwide market continues to grow and as data acquisition and processing become more routine.

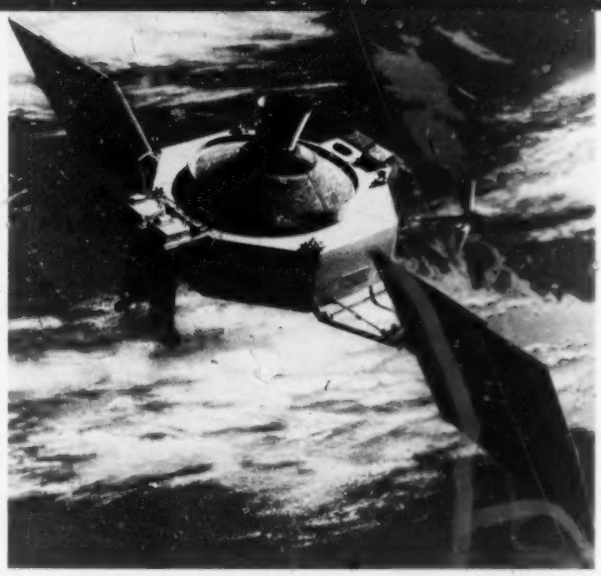
Manufacturing in Space

Space manufacturing and processing of materials, though not yet a reality, is the area that holds the great promise of true commercialization of space activity. The basic attraction of space is the essential neutralization of gravitational forces necessary to keep a satellite in orbit. Since an orbiting Shuttle, space station or platform is at or near "zero-G," or weightlessness, convection of heat and other gravitational effects normally encountered in processing materials can be avoided. This holds fascinating prospects for metallurgists, for those interested in crystal growth, for manufacturers of certain pharmaceuticals, and potentially for a host of others. The Soviet Union, the Federal Republic of Germany, Sweden and Japan are most active in pursuing these possibilities. It has been reported that Japan envisions a multi-billion dollar annual market for itself in space products in the mid-1990s, and that space-processed materials are a substantial portion of this market. The Soviet Union has conducted repeated, extensive experiments in manufacturing on its manned flights over the past decade or so.

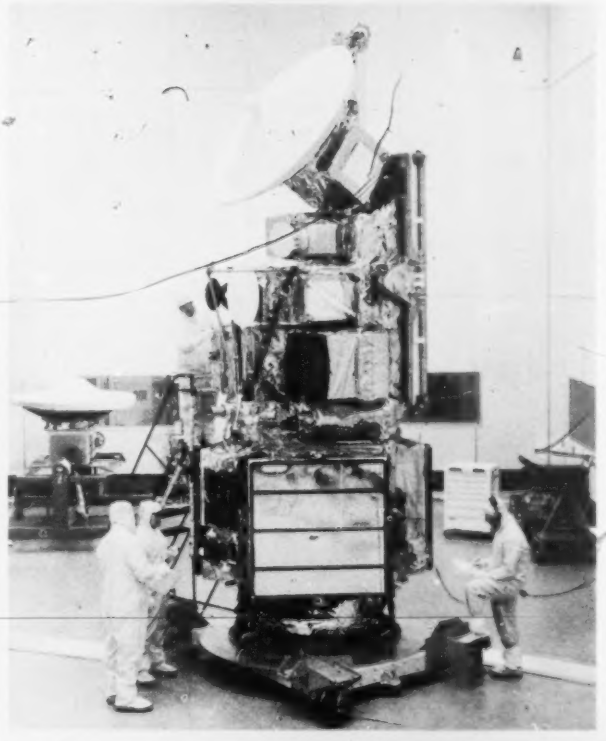
For the U.S., let me mention one rather fascinating development—fascinating both for its technology and by virtue of the fact that it is a commercial endeavor. Under an agreement with NASA, the Johnson and Johnson pharmaceutical house and McDonnell Douglas have pioneered an ambitious series of experiments in electrophoresis, a process by which a fluid may be separated into constituent parts. Convection limits the effectivity of electrophoresis here on Earth. On the most recent Shuttle flight, a small, continuous flow electrophoresis device developed by this commercial team at their expense was flown free of charge. It operated to perfection, separating albumin into its pure constituent parts, with a throughput better than 400 percent of operation at Earth gravity. This holds great promise for such products as Interferon and other materials that might be useful in treating various anemias, diabetes, hemophilia, emphysema and other serious, sometimes fatal ailments.

Under this agreement with NASA, the partners plan seven more test flights, and then hope to go into commercial production, eventually having a small factory—there's no other name for it—in space for several months at a time, with the Shuttle paying periodic visits to deliver raw materials and retrieve the product.

Another company, GTI Corporation, is producing at risk a furnace for Space Shuttle metallurgical uses. And at least two other U.S. firms plan experimental

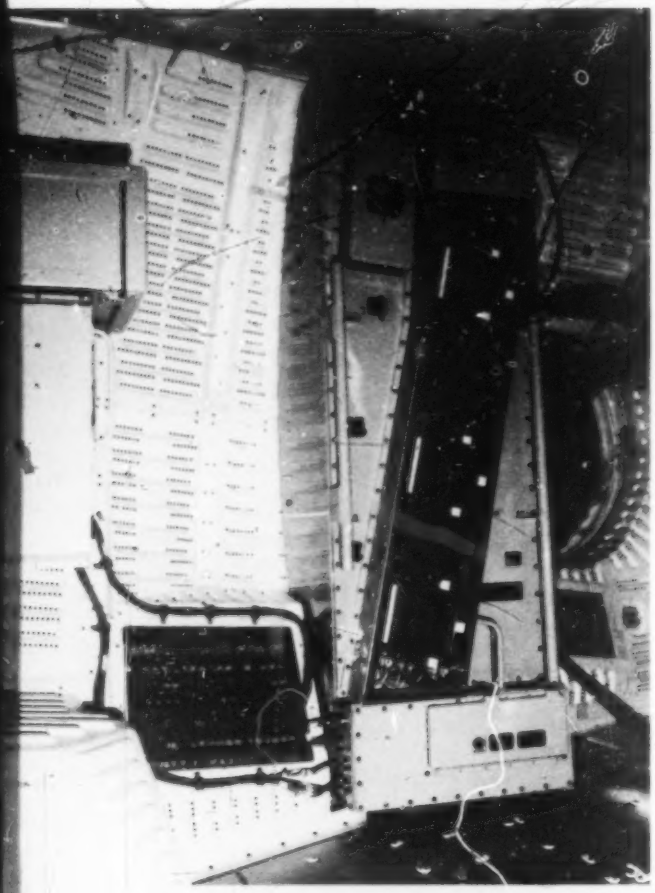


A Boeing Aerospace Company commercial space venture is the MESA orbiting platform, which provides in-space propulsion, electrical power and other services to customers' instrument packages. MESA satellites will be launched as secondary "piggy-back" payloads aboard the French Ariane. Boeing is building a similar platform for Sweden's Viking satellite, scheduled for 1984 launch.

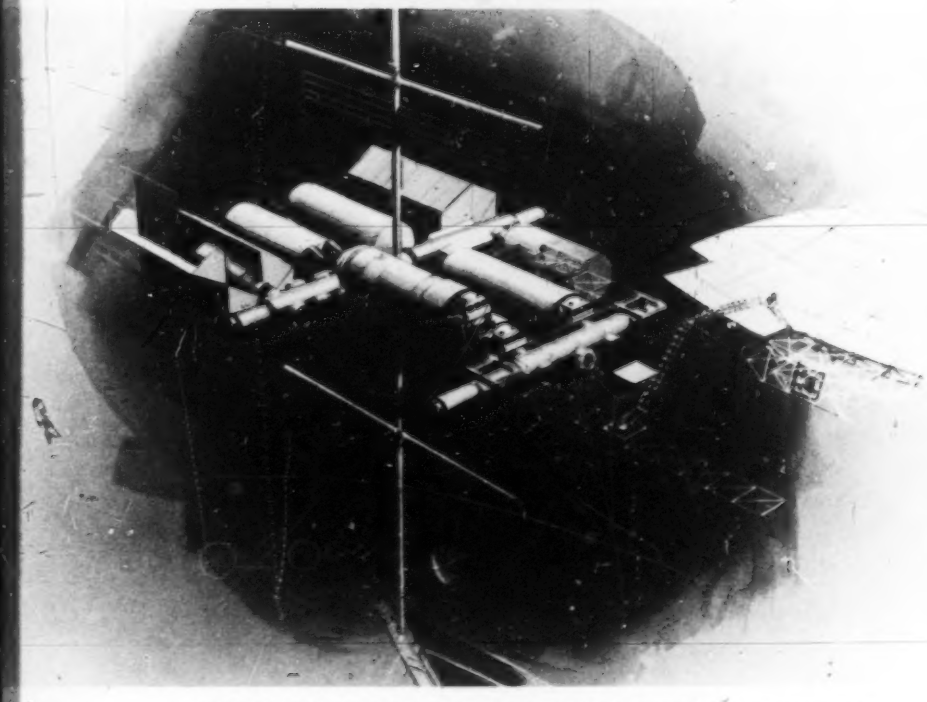


Launched in July, NASA's Landsat 4 is the latest and most advanced of the U.S. family of Earth resources monitoring satellites; it was built by General Electric's Space Systems Division. Remote sensing satellites of this type offer potential for provision of commercial information services in such fields as agriculture, forestry, oil and mineral exploration.

Although NASA's Landsats are the only operational Earth resources survey satellites, competition is coming from Europe and possibly Japan. The first competitor, scheduled for 1984 launch, is the French-built SPOT Earth observation satellite, jointly sponsored by France, Belgium and Sweden. The device pictured is SPOT's image-taking system, called HRV, for High Resolution Visible. Two HRV cameras, each operating independently, make up the payload of the SPOT spacecraft.



Installed in the mid-deck of the Orbiter *Columbia* for the Space Shuttle's fourth flight, this "gray box" housed a historic experiment. Called EOS and designed by McDonnell Douglas Astronautics Company, the system successfully demonstrated electrical separation of the components of a chemical compound in the first U.S. experiment in orbital materials processing. Company studies indicate that processing in the weightless environment could yield pharmaceuticals with a fivefold improvement in purity for more effective treatment of many diseases.



A space station would spur development of commercial orbital enterprises, particularly in the field of space manufacturing, which holds promise for a range of superior products that cannot be processed in Earth gravity. The orbital factory could be one or more modules of the station, or it could be a free-flying facility tended by space station crews. The illustration is a Boeing Aerospace concept of a 1990s space station.

processing work on upcoming flights.

West Germans are focusing on materials processing much more intensively. Two groups of West German companies will conduct processing studies, beginning with the first flight of Spacelab aboard the Shuttle, scheduled for next year, and on a second flight in 1985.

European as well as U.S. firms have begun to draw a cloak of industrial secrecy around their development of volume production processes in space. If, as many now believe, space processing becomes a going business, the need will quickly arise for one or more permanent orbital facilities to house and provide power for the equipment required. It is not economical to rely on the Shuttle—which at best can stay in space for only a few weeks—for this purpose. Two American firms have already approached NASA with investment plans for this end of the business. One would develop a small, unmanned platform capable of being deployed and retrieved by the Shuttle. The Germans have a similar plan with their Eureca vehicle. The other U.S. firm is interested in exploring private ownership of a portion of a manned space station, together with co-orbiting free-flyers, for manufacturing and other commercial purposes. In a related development, The Boeing Company is selling its MESA spacecraft. A small orbital platform for communications, remote sensing or other equipment, MESA will be launched by Ariane. Sweden is the first MESA buyer.

Let me sum up the situation. Communications satellites, their use, and associated ground equipment will continue as a highly lucrative, international commercial business for the foreseeable future. The need for hundreds of these satellites, coupled with the potential need for similar numbers of launches in support of materials processing in space, is attracting capital investment and private operation in the ground processing and space launch businesses. Private enterprise will move quickly as it senses the opportunity for very large financial gains in space processing. In turn, growth in processing will require platforms or other types of space stations to provide power, stability, and other forms of support to the processing factories. All of this together could bring about, by the late 1980s or early 1990s, a strong surge of private investment that would indeed bring us to the beginning of Space Phase III: The Commercial Era.

In the 17th Century, La Rochefoucauld wrote: "In great affairs we ought to apply ourselves less to creating chances than to profiting from those that events offer."

The era on which we will soon embark offers unlimited chances for profit, not merely in economic gains, but in growth for the human mind and spirit and in fulfilling mankind's practical needs. Now that we have taken our first steps into this heretofore unexplored region, it is up to us to have the will, the vision and the imagination to rise to these challenges.

COSPAS/SARSAT:

Space-based Lifeguard

By JAMES J. HAGGERTY

Last September 9, a single-engine lightplane crashed in a remote wilderness of British Columbia, seriously injuring three men aboard. Fortunately, the crash impact set off the plane's emergency locator beacon. The beacon's signal was picked up by a newly-orbited satellite, which in turn relayed the alert to the Canadian Forces Rescue Control Center in Trenton, Ontario. The morning after the accident, a DeHavilland Canada Buffalo rescue transport reached the site pinpointed by the satellite and found the three airmen. All have since recovered but, according to Canadian officials, one was so badly injured he might not have survived had it not been for prompt location of the downed airplane.

That marked the first successful rescue assist accomplished by a new global search and rescue system called COSPAS/SARSAT, a multi-nation cooperative program that is still in development but quasi-operational with one satellite in orbit. SARSAT, a joint project of the U.S., Canada and France, is a compression of Satellite-aided Search and Rescue System; COSPAS is the Russian equivalent. The COSPAS segment of the system, already in orbital service, is being developed independently but is designed for compatibility with SARSAT. The United Kingdom and Norway, though not engaged in development, are participating in evaluation of the system. U.S. agencies involved in SARSAT are NASA, the National Oceanic and Atmospheric Administration (NOAA), the Air Force and the Coast Guard. The first SARSAT system will be launched in February 1983 aboard the RCA-built NOAA-8 weather satellite; three additional SARSAT systems are being built.

The system is not a satellite wholly dedicated to the search and rescue function, but an electronic package carried as a secondary payload aboard operational weather, navigation or other satellites. COSPAS/SARSAT reached flight status on June 30 with the launch of COSPAS I, also known as Cosmos 1383, part of a Soviet navigational satellite network.

Within a month after the British Columbia rescue, COSPAS/SARSAT scored three more emergency locations, one in Quebec, another in New Mexico and a third 300 miles offshore of Massachusetts. The latter was the first maritime rescue assist for COSPAS/SARSAT, involving a trimaran capsized in 30-foot waves with three aboard. A USAF station at Scott AFB, Illinois picked up the beacon signal relayed by COSPAS I and directed a Coast Guard cutter to the rescue.

COSPAS/SARSAT fills a long-standing need for a better way of detecting and locating signals from downed aircraft or troubled ships. Virtually all seagoing vessels and many aircraft carry radio beacons whose beams are activated either automatically or manually in an emergency. The problem has been that there existed no means of *continuously* monitoring beacon signals, and when beacon transmissions were picked up rescue coordinators frequently encountered difficulties in tracing the signals' source.

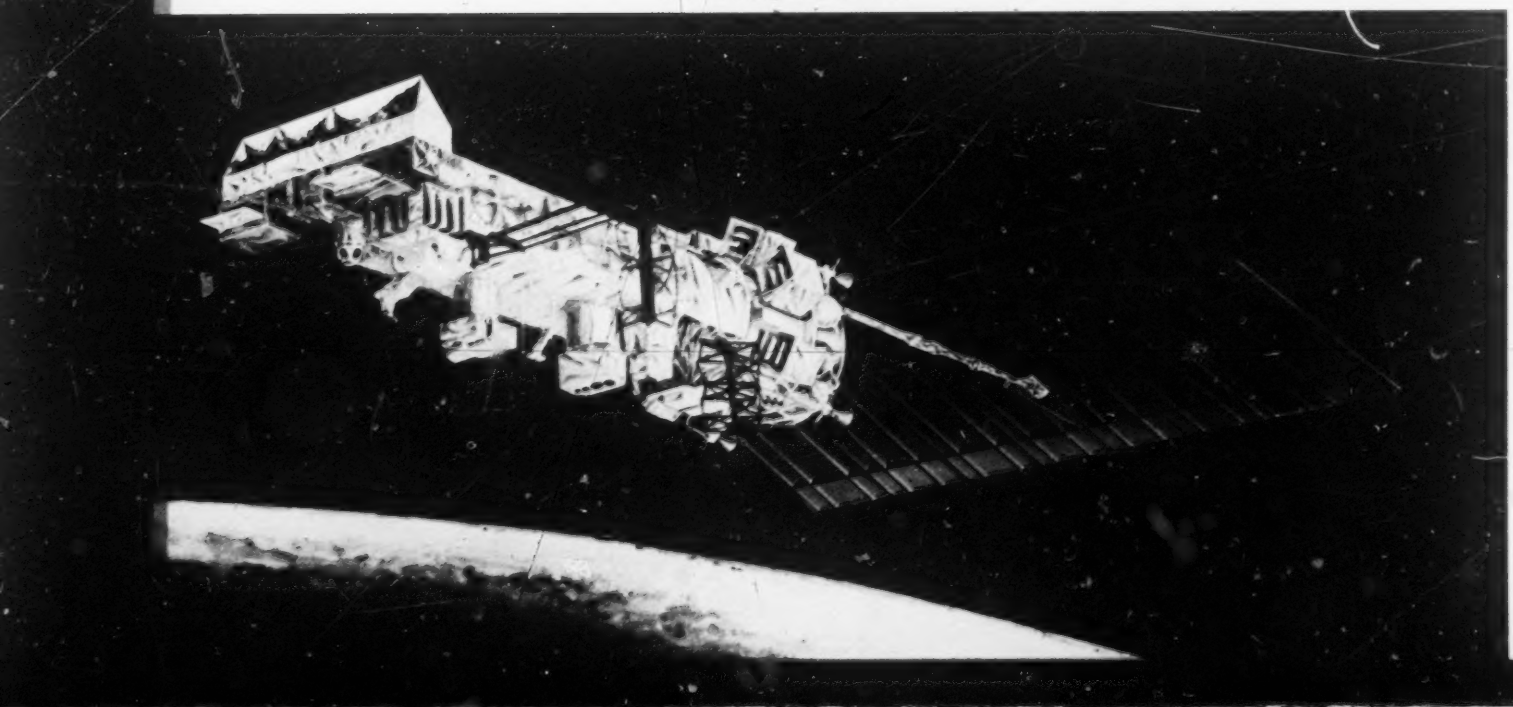
COSPAS/SARSAT solves those problems by providing an orbital monitoring platform equipped with advanced electronics compatible with computerized locating equipment at ground stations all over the world. The satellites "listen" continuously on emergency frequencies used by ships and aircraft. When the spaceborne equipment picks up an alert, it relays the information to a ground-based local user station. Within minutes, the station's computer produces a position fix, locating the distressed craft within 12 miles if it is equipped with existing types of beacons, three miles if it has a new, specially-designed beacon being developed. Search and rescue centers are notified that an emergency has occurred and advised of the whereabouts.

COSPAS/SARSAT will undergo a 12 to 18 month period of evaluation with electronic packages aboard COSPAS I and NOAA-8. NASA says a successful demonstration could lead to establishment of an international operational system.

On the basis of early returns, COSPAS/SARSAT looks like a winner. In a short period of service, the system has been credited with saving seven lives on four rescue assists. Equally impressive is its cost effectiveness, exemplified by the British Columbia rescue. Accurate satellite data and computerized position fixing virtually eliminated the "search" phase and held the rescue phase to a single flight—at a cost of about $2,000 an hour. Just prior to that incident, the Canadians had spent more than $3 million in an unsuccessful multi-sortie search for a downed airman in the same area. It would be pretty hard for the most dedicated budget cutter in any of the participating nations to argue against funding a system that not only increases the probability of saving lives but does it enormously cheaper, so the search and rescue system is a good bet for operational service in 1985-86.

Artist's impression shows the operation of the COSPAS/SARSAT international search and rescue system: at left, the distressed ship or aircraft transmits an emergency signal that is picked up by a satellite; the satellite relays signal time and direction to an Earth station, where the data is computer-processed; the receiving station alerts a rescue center and advises the location of the emergency.

The NOAA-8 spacecraft is basically a weather satellite but it will carry as secondary payload an electronic equipment package—called SARSAT—for space-based relay of emergency signals from troubled ships or aircraft. Built by RCA Astro-Electronics, NOAA-8 is scheduled for February 1983 launch.



The USAF's 11th Chief of Staff, General Charles A. Gabriel assumed that post in July after an assignment as Commander in Chief, U.S. Air Forces in Europe and Commander, Allied Air Forces Central Europe. In prior duty, he had been USAF Deputy Chief of Staff, Plans and Readiness; Deputy Chief of Staff, Operations, Tactical Air Command; and Air Force Officer Commanding, U.S. Air Force Academy. This article is adapted from his remarks to the Air Force Association National Convention.

THE AIR FORCE

A [illegible] on the USAF's 35th anniversary

By GENERAL [illegible]

This year marks an important milestone in the rich history of the Air Force, our 35th anniversary as a separate service. It is also the 75th anniversary of military aviation.

In August of 1907, the Army Signal Corps assigned one officer, two enlisted men, and a civilian clerk to its new Aeronautical Division. In the summers of 1908 and 1909, the Wright *Flyer* thrilled thousands of spectators who watched at Fort Myer as Wilbur and Orville flight-tested improved versions of their 1905 model. It was not until August 1909 that the Army finally accepted "Aeroplane No. 1". Three months later, the nation temporarily lost its total air strength when the plane crashed.

By comparison to the initial four-man Air Force, today we have over 800,000—about 100,000 officers, some 475,000 enlisted personnel, and about 250,000 civilian employees in the active force. The Air Reserve forces add more than 240,000 highly capable men and women to the total force, with the Air National Guard topping 100,000 for the first time. The Air Force was born—and remains—a product of foresight, drive, and technology. In a few amazing decades, we have come from the silk scarf and biplane to operational space flight.

I do not need to belabor the threat we face in the dangerous and turbulent years ahead. I have spent a lot of time over the past couple of years in Europe, wrestling with the numbers the Soviets have lined up against us. We all know the Soviets outspend, outman, and outproduce us. I will not take up your time to recount these statistics. What I will do is tell you what we are doing to counter this threat.

We have come out of the long, dark decade of the 1970s when we, as a nation, failed to maintain our military strength. We are now moving in the right direction to rebuild our warfighting

capability. Our priorities remain: to take care of our people; to modernize our strategic nuclear forces; to increase the readiness and staying power of our general purpose forces; to expand our airlift capability; and to modernize and expand our tactical forces.

We don't expect to match the Soviet Union in numbers, nor do we need to. We depend on the high quality of our people and on superior training, tactics, and technology to give us the critical edge in combat. We will hold onto this edge—just as the early air pioneers did—through the dedication of our people, and through our determination to exploit technological change to its fullest.

The attitude of our people in the field has never been better. Their driving motivation is their dedication to serve in the nation's defense. We can all learn much from the courageous life of the legendary airman Sir Douglas Bader, who died recently. Although he lost his legs in a flying accident in 1931, he mastered his artificial legs, rejoined the Royal Air Force in 1939 and became an ace with 22 confirmed kills during the Battle of Britain. In August 1941, he was captured after his plane collided with an enemy aircraft; one of his artificial legs was crushed in the crash. The Germans so respected Sir Douglas that they asked the R.A.F. to airdrop a new pair of legs for him. The R.A.F. did so, but mixed in, of course, with a bomb drop. Sir Douglas got his new legs. However, after his fourth escape attempt, the Germans decided to lock up his legs each night.

We don't expect to match the Soviet Union in numbers, nor do we need to. We depend on the high quality of our people and on superior training, tactics and technology to give us the critical edge in combat.

Our highly-qualified, well trained and motivated crews, and the people who support them, will be the key to success or failure in combat. The bad situation our people faced in the late 1970s has been turned around to a large extent through improved pay and benefits, better working and living conditions, and a marked increase in public pride in the military. As President Reagan has said, "it is once again an honor to wear the uniform."

Our experienced people are staying in, and as a result our combat capability is improving. Retention rates for pilots in the six-to-eleven year group have increased from 26 percent in 1979 to 66 percent today. And first-term reenlistment rates have increased from 38 percent to 58 percent. When we retain our people, we are keeping trained combat capability. When our experienced people leave, we have to recruit and train all over again. This not only costs more, it continually puts us in a training mode—never quite ready.

The combination of our experienced people staying with us and increased funding for operations and support over the past couple of years has had a good effect on the readiness and morale of our combat forces. In the late 1970s, we didn't have enough money in these accounts. Many of our bases were in a sad state of repair—roofs were leaking, buildings needed painting, runways needed patching, and flying time was not what it should have been. These "nuts and bolts" items had a negative effect on morale and caused us to lose training opportunities. Now our crews are flying more, training more effectively, and our stocks

TODAY

of munitions and spare parts are beginning to fill.

Today, our combat crews are well-supported and ready; they are expertly trained in superior tactics; and they have modern, high-technology equipment. This is a far cry from the days of Lieutenant Benny Foulois. As the only officer on flying duty in early 1910, he taught himself how to fly in the only plane the Army had. Foulois received instruction from the Wrights by mail, becoming the first correspondence school pilot in history. The Wrights later sent him an instructor to help with the hardest part—landing. Over the next months and years, the young air pioneers trained hard and developed the tactics to turn the airplane into an effective military weapon. They did the best they could with what they had and worked hard to show the Army and Navy how airpower could contribute to joint operations.

To insure our nation has the most effective warfighting forces, we will plan, equip, train, and operate in close harmony with the other services and our allies. It will not be easy for some to shed parochial concerns. But we cannot afford separate approaches that waste scarce resources and do not give us the best warfighting capability.

We are working with the Navy on several initiatives to increase cooperation and training. We and the Navy will be expanding our use of each other's schools, increasing the scope and frequency to joint maritime training and exercises, and developing better ways to fight together. As the Falklands conflict demonstrated, air power is a critically important part of successful maritime operations. We will be putting more emphasis on collateral roles such as sea-lane protection, aerial minelaying and ship attack. We can learn from on another what we need to know—both on the offense and the defense.

For training to give us the best results, we have to train the way we would fight—in aggressive, realistic conditions, in programs designed to insure that all of our operational crews around the world learn to fly as a unit in conditions we would expect in combat. Large scale mock combat exercises against threat systems which closely match Soviet equipment have become an integral part of our training in recent years. We will continue them, improve them.

In the past two years, Air Force units took part in 125 joint exercises, including the Reforger 82 exercise in Europe, the largest strategic airlift deployment of troops ever. During the exercise, over 18,000 Army troops and more than 950 tons of cargo were airlifted from the U.S. to Europe on C-141s and C-5s, augmented by civilian aircraft.

The best-equipped combat forces are of little value if they can't be brought to the battle on time. The C-5B and KC-10 programs, along with expansion of the Civil Reserve Air Fleet (CRAF), will greatly improve our ability to get troops and supplies to the battle. On Easter Sunday 1949 during the Berlin Airlift, allied planes hauled 13,000 tons of supplies on 1,400 flights. Today, the C-5 could carry that many tons in just 117 flights. Despite improvements in our airlift capability, we're still short of what we need. A new aircraft, like the C-17, could add the needed long-range and intra-theater lift.

While we continue to rely heavily on our people, tactics and training to offset Soviet advantages, I am increasingly concerned about the other driving element—technology. Since the early days of air power, technological advances have been our ace in the hole. We have to stay on the frontiers of technology and protect our advantages in equipment. We can't afford to let our critical technological advantages slip away or be stolen away into the armaments industries of the Soviet Union and its allies.

The leakage of western technology, through legal and illegal means, has helped the Soviets close the gap. For example, our leads in radar and computers have been cut drastically through the transfer of militarily relevant technologies from the West to the East. While some steps have been taken to strengthen national and international controls on such transfers, all of us—including industry—need to do a better job of protecting the technologies and know-how we need to deter Soviet aggression. We cannot allow our combat capability to be threatened by Western technology in Soviet hands.

As demonstrated in Lebanon, the quality of our equipment is excellent. However, our production is not where it should be; we would be foolish to repeat

Through evolutionary improvements, the USAF will increase the air-to-surface, night and in-weather capabilities of the McDonnell Douglas F-15 (above) and (below) the General Dynamics F-16, while building toward a goal of 44 tactical fighter wings.

The leakage of western technology, through legal and illegal means, has helped the Soviets close the gap . . . We cannot allow our combat capability to be threatened by Western technology in Soviet hands.

the near catastrophe the nation faced in the late 1930s with war on the horizon. In September 1939, the Air Corps had only 800 first-line aircraft, while Germany had more than 4,000 aircraft of better quality. The one exception was our B-17, which was better than the German bombers of that time, but we only had 23 on hand.

We may never again have the luxury of two years or more to change the equation, as we did then. Fortunately, we have the best tactical fighters in the world today. We are committed to a stable production program for F-15s and F-16s, and through evolutionary improvements we will increase their air-to-surface, night, and in-weather capabilities. For the longer term, we will continue to build toward our goal of 44 tactical fighter wings.

The E-3A (AWACS) is another example of how technology has been applied to extend our combat capability. In times of crisis, we used to say, "Send in the Marines!" Now AWACS is helping fill this role. As shown in recent crises in Europe, Korea, and Southwest Asia, the AWACS increased our surveillance and warning and demonstrated our nation's commitment and resolve. The AWACS gets to the scene quickly; it is non-lethal—it shoots electrons and not bullets; and it greatly improves the effectiveness of our fighters in battle.

Our most critical technological challenge is in the rebuilding of our strategic nuclear forces, forces that have kept us from war with the Soviet Union for the past 37 years. The bomber and missile legs of our strategic Triad have been sadly neglected. Our youngest B-52 is 20 years old, and our ICBM forces date from the 1960s. In the past decade alone, the Soviets have deployed three new ICBMs with 10 improved versions; during the same period, we deployed no new ICBMs and only one Minuteman upgrade.

The B-1B program is going well and enjoys continued Congressional support. The B-1B is not the same as the original B-1 of the 1970s; it is a big jump ahead. Using "Stealth" technology, the B-1B will have only 1/100th of the radar cross-section of the B-52, making it tough to detect and track. The B-1B will be able to penetrate the projected Soviet air defense network through the 1990s and will stress Soviet defenses. We need it to attack the imprecisely located and mobile targets that only a manned bomber can hit.

As our B-52s become less able to penetrate, and our new B-1Bs come on line, we will be converting most of our B-52s into stand-off cruise missile carriers. The remaining B-52s will be used in force projection, conventional bombing, and maritime roles. We are also moving at the fastest reasonable pace to develop an advanced technology bomber that

In the 1949 Berlin Airlift, allied planes hauled 13,000 tons of supplies on 1,400 flights in a single day. The USAF's Lockheed C-5B can carry equivalent tonnage in only 117 flights.

Using "stealth" technology, the Rockwell B-1B will have only 1/100th the radar cross-section of the B-52, making it tough to detect and track.

will insure our ability to penetrate advanced Soviet defenses in the next century.

Technology also holds the key to restoring the credibility of the ICBM leg of the Triad. Our ICBM force is in danger. The Soviets have improved the accuracy of their missiles faster than we had expected and these missiles greatly increase the vulnerability of our Minutemen and Titans. In the coming years, the Soviets could destroy about 90 percent of our ICBMs in a first strike while using only a relatively small portion of their force.

We have worked long and hard on this problem and, after looking at a number of basing approaches for the M-X, we believe we have found a solution to this destabilizing situation. We have made our recommendation to Secretary Weinberger on the best way to base the M-X to insure the survivability and retaliatory power of our ICBMs for many years to come. The administration plans to make its final decision on M-X basing by December.

The brightest scientists and analysts we could find have looked at the basing concept we are recommending and have tried to find reasons why it might not work. None of these experts, not even those skeptical at first, has been able to come up with a show-stopper. We believe we have a feasible basing concept that will be effective against current and projected Soviet threats. It takes advantage of America's technological capabilities; it is technology over numbers.

Our ICBM force is in danger. The Soviets have improved the accuracy of their missiles faster than we had expected and these missiles greatly increase the vulnerability of our Minutemen and Titans.

Unlike our current Minuteman force, M-X with survivable basing would not be vulnerable to Soviet numbers. It will turn the tables on the Soviets. They will have to expand scarce resources on protecting their ICBMs rather than expanding them. And they will be forced to look for technological rather than number solutions—our game rather than theirs.

To sum up, carrying out President Reagan's strategic modernization program, including the deployment of M-X, the B-1B and the Navy's Trident D-5, will close the window of vulnerability. We will restore the strength and credibility of our strategic forces by taking advantage of this country's technological and industrial genius.

Our president has taken a bold step to begin Strategic Arms Reductions Talks (START) with the Soviet Union. Arms control is not a substitute for modernization. At the reduced levels proposed in START, modernization of our strategic forces is all the more necessary. With these programs underway, the United States is able to negotiate from a position of strength, making equitable and verifiable reductions in strategic modernization last fall provided the Soviets the incentive to come to the negotiating table.

I am proud of our Air Force today. It's the world's best. With your help, we're going to keep it that way. Our dedicated people and our advantages in tactics, training and technology will continue to give us the warfighting capability we need. We will be able to deter the Soviets from war as long as they remain convinced that we have the strength—*and the resolve to use it.*

As America has shown so many times in the past, we have the will, the ingenuity, and the resources to do what is necessary to maintain our power and thus preserve the peace. Strength does not invite war; weakness does.

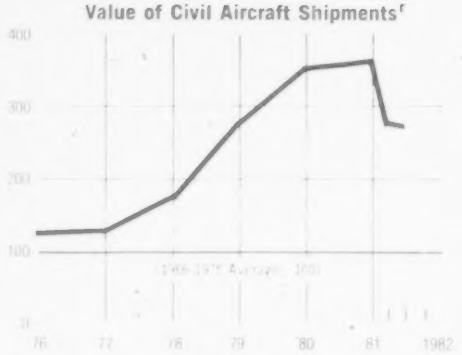
The Boeing-built E-3A AWACS (inset) provides a significantly increased surveillance and warning capability. A technician is preparing the E-3A's 30-foot-diameter radome for static test.

AEROSPACE ECONOMIC INDICATORS

CURRENT

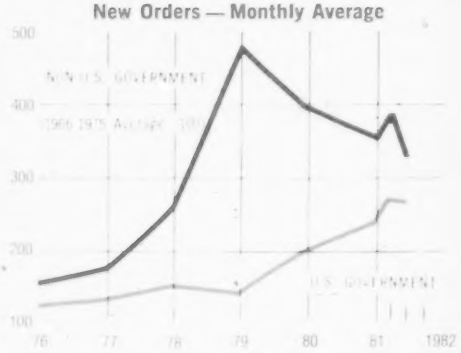
Total Aerospace Sales

Value of Civil Aircraft Shipments[r]



OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	AVERAGE 1966-1975	SAME PERIOD YEAR AGO	PRECEDING PERIOD**	LATEST PERIOD 2nd QTR. 1982[r]
AEROSPACE SALES: TOTAL	Billion $	Annually***	24.2	64.8	69.6[r]	70.1
(as reported by the Bureau of the Census)	Billion $	Quarterly	6.1	17.6	16.7[r]	18.1
AEROSPACE SALES: TOTAL	*Billion $*	*Annually****	*25.6*	*34.5[r]*	*35.0[r]*	*34.7*
(In Constant Dollars, 1972=100)	*Billion $*	*Quarterly*	*6.4*	*9.1[r]*	*8.2[r]*	*8.8*
AEROSPACE PRIME CONTRACT AWARDS: TOTAL	Billion $	Quarterly	5.8	19.6	19.4[r]	17.9
U.S. Government	Billion $	Quarterly	4.1	9.7	11.0[r]	10.9
Other Customers	Billion $	Quarterly	1.7	9.9	8.4[r]	7.0
BACKLOG (Major Aerospace Mfgrs): TOTAL	Billion $	Quarterly	28.6	96.1	95.9[r]	96.3
U.S. Government	Billion $	Quarterly	15.9	41.9	45.5[r]	47.1
Other Customers	Billion $	Quarterly	12.7	54.2	50.4[r]	49.2
DEPARTMENT OF DEFENSE						
Aerospace Obligations: TOTAL	Million $	Quarterly	2,712	5,819	8,747	7,317
Aircraft Procurement	Million $	Quarterly	1,986	4,797	7,015	5,891
Missiles Procurement	Million $	Quarterly	726	1,022	1,732	1,426
Aerospace Outlays: TOTAL	Million $	Quarterly	2,405	4,551	4,844	5,789
Aircraft Procurement	Million $	Quarterly	1,741	3,563	3,888	4,500
Missiles Procurement	Million $	Quarterly	664	988	956	1,289
NASA RESEARCH AND DEVELOPMENT						
Obligations	Million $	Quarterly	780	1,138	1,688	1,358
Expenditures	Million $	Quarterly	789	1,166	1,155	1,144
EXPORTS						
Total (Including Military)	Million $	Quarterly	1,038	4,987	4,153	3,927
New Commercial Transports	Million $	Quarterly	345	2,282	1,410	1,088
EMPLOYMENT: TOTAL	Thousands	End of Quarter	1,166	1,211	1,178[r]	1,164
Aircraft	Thousands	End of Quarter	650	659	626[r]	612
Missiles & Space	Thousands	End of Quarter	114	120	125[r]	128
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	End of Quarter	4.38	10.18	10.93	11.10
PROFITS (after tax) BASED ON SALES						
Aerospace	Percent	Annually***	2.7	4.7	3.7	3.4
	Percent	Quarterly	2.7	4.5	3.2	3.2
All Manufacturing	Percent	Annually***	4.8	4.8	4.5	4.2
	Percent	Quarterly	4.8	5.3	3.8	3.9

*1966-1975-quarterly averages are computed as one-fourth of annual averages
**Preceding period refers to quarter preceding latest period shown
***Annual data are computed as the sum of the previous four quarters
r Revised

Source: Aerospace Industries Association

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aerospace

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AEROSPACE REVIEW AND FORECAST

1982/1983

Notable views of notable people on aerospace matters...

President Ronald Reagan, *in a White House press conference:*
"I don't question the fact that the people are concerned (about defense spending) because they have been receiving, through much of the media, a constant drumbeat that somehow this is a needless extravagance and that we're overboard on this particular subject . . .

"You will find that in constant dollars the defense budget is just about the same as it's been all the way back to 1962. You will also find that, as a percentage of Gross National Product, it is smaller than it was in the Eisenhower and Kennedy years. We repeatedly see the figures, over a five year period, of $1.5 trillion or $1.6 trillion (for defense). Well, we're still spending more than $2 trillion in that five years on social programs . . .

"If (defense spending) can be cut, it will be cut. But the priority must be: not if it means reducing our ability below the level at which we can declare ourselves safe."

John G. Kester, *Washington attorney and former special assistant to the Secretary of Defense, writing in The Washingtonian magazine:*
"To suggest that we cannot afford the defense dollars the Administration wants is nonsense. Under John Kennedy in 1961, this country spent nine percent of its Gross National Product—half the federal budget—on defense. Today we allocate only a bit more than six percent of GNP—a quarter of the federal budget—to defense. Meanwhile, the Soviets have steadily added to their own military expenditures every year for 20 years.

"What has changed in this country over two decades is the addition of so many costly activities and income redistribution programs, many of them written into law as automatic 'entitlements' that, unlike defense, do not have to be re-enacted each year. They are 39 percent of the federal budget, versus 28 percent for defense. Social Security is by far the costliest in budget terms; it was one percent of the federal budget in 1950 and it is 26 percent and out of control today. Cutting the defense budget amounts to stripping the defense of the United States in order to write bigger Social Security checks. That's the unpleasant economic contest of our times—our parents versus our children."

Frank C. Carlucci, *president, Sears World Trade Inc. and former Deputy Secretary of Defense, in New York Times interview:*
"(It is) becoming much more difficult to accomplish a mission in government (because) we put a premium on over-the-shoulder watchers, whether they're Congressional staffers, investigative reporters, the Freedom of Information Act, White House supervisors or more auditors, more inspectors—all of which are good things, but we have to keep them in balance. We have to put an equal premium on the guy who accomplishes his mission, takes a risk, and we have to reward him commensurate with his achievement. We do not do that in government . . .

"Let's keep our eye on mission accomplishment and not be diverted by subsidiary issues. Yes, economies and efficiencies in defense are important because (Defense) is the largest government agency. And an awful lot is being done in that area. But they are not ends in themselves. The end is protection of the national security. The real issue is how this country copes with the growing Soviet threat. We provide a service much like firemen and policemen. It's wasteful when you don't need it, but when you need it every cent of it is worth it."

Harry J. Gray, *chairman and chief executive officer, United Technologies Corporation, addressing the Convergence '82 conference in Dearborn, Michigan:*
"Industrial countries must revitalize their troubled economies without resorting to trade barriers. We have the resources. We just need the insight to recognize and understand these resources and the creativity to apply them.

"We hear a lot of talk about industrial decline. In my judgment, however, what appears to be a *decline* is really a *transition* to a new era of productivity, profitability and prosperity. The key to this transition is technology. We can create this new era if we apply our technological resources—and if we encourage and support continued technological innovation."

George W. James, *senior vice president—economics and finance, Air Transport Association of America, in an address to the Society of Airline Analysts in New York:*
"I believe (there) are developments pointing to a possible positioning for an airline economic recovery beginning in 1983 . . . The signs are already developing that the airlines are making progress in preparing for the economic upturn and the resulting financial benefit. Let me note the following:

"Costs are coming down . . . numbers of employees have dropped and the rate of increase in average cost per employee is declining . . . fuel prices have been declining . . . the breakeven passenger load factor is dropping . . . interest expense is declining . . . during the second and third quarters of 1982 the airlines recorded an operating profit of $500 million . . . For 1983, industry passenger traffic should continue to improve—up three to five percent, depending on the degree of upturn in the U.S. economy . . .

"U.S. industry has averaged about a five percent net profit margin historically, although (in 1982 it) dropped to about four percent. The U.S. airline industry should have about $2.5 billion to $3 billion operating profit annually to match the U.S. industry average . . . The airlines are a long way from attaining such a performance. Although the stage is being set in the industry to maximize the benefits of recovery in the U.S. economy, only time will really tell when these benefits will actually be realized."

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1982/1983

The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems.

Foster understanding of the aerospace industry's responsibilities in the space exploration program.

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade.

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

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Aerospace Issues for 1983

By KARL G. HARR, JR.
President, Aerospace Industries Association

This issue of *Aerospace* is an illustrated report on the 1982 activities of the aerospace industry. It shows that the industry is generally healthy, with high levels of activity in defense and space work and a very substantial backlog of orders, but that there is one trouble area: sales of civil aircraft—in particular, commercial transports. Last year, civil aircraft sales dropped dramatically and we expect a further decline this year. The world economy, of course, is the big reason and an economic turnaround would solve much of the problem. But we are also getting increasingly effective competition from foreign aircraft manufacturers, who have a big competitive edge in the degree of support they receive from their governments.

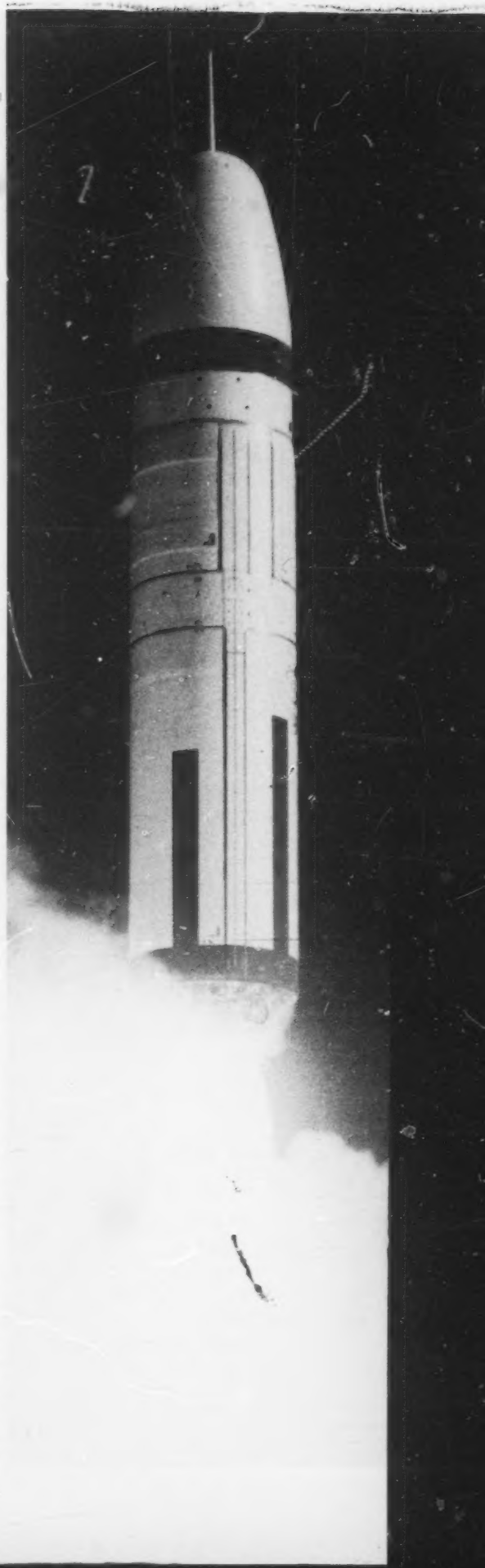
Realistically, the U.S. aerospace industry is not going to get that kind of support from the U.S. government—but it should get more support than it currently enjoys, considering the importance of high-value commercial aircraft exports to our economy. So this year the industry will focus much of its attention on obtaining and sustaining a higher national priority on exports as a matter of government policy as well as industrial policy. I think we're already finding considerable support for those objectives in both the Administration and the Congress. Hand in hand with increased emphasis on exports, we must obtain and sustain a higher national priority, in both the public and the private sectors, on research and development as a fundamental keystone of our competitive strength.

There is another matter of particular importance: Independent Research and Development, or IR&D. The term "independent" refers to research initiated and funded by a firm to advance company technology in order to remain competitive. In the case of such research, the IR&D funds expended by a company are recovered in the price of its goods and services, including those sold to the Defense Department. An auto manufacturer, for example, recovers the cost of research in the price of the automobile. But when an aerospace firm charges such expense to a defense contract, some people seem to think it's a ripoff. It is, in fact, as the Department of Defense will testify, a normal expense of doing business that is an absolutely essential cost of maintaining our technical capabilities.

In last year's "lame duck" session, Congress passed legislation that put a cap on IR&D in this fiscal year and next, and called for making IR&D a line item of the Defense budget in Fiscal Year 1985. Without getting into the complexities, that would essentially take the *independence* out of Independent Research and Development, with severe impact on industry's ability to maintain its technological strength. IR&D limitations also tend to discourage competition among companies, to the detriment of our defense posture. So the industry will give top priority in the months ahead to the task of educating the Congress as to the validity and importance of IR&D to industry's competitive status and to our national defense.

AEROSPACE HIGHLIGHTS 1982

BY JAMES J. HAGGERTY



Defense

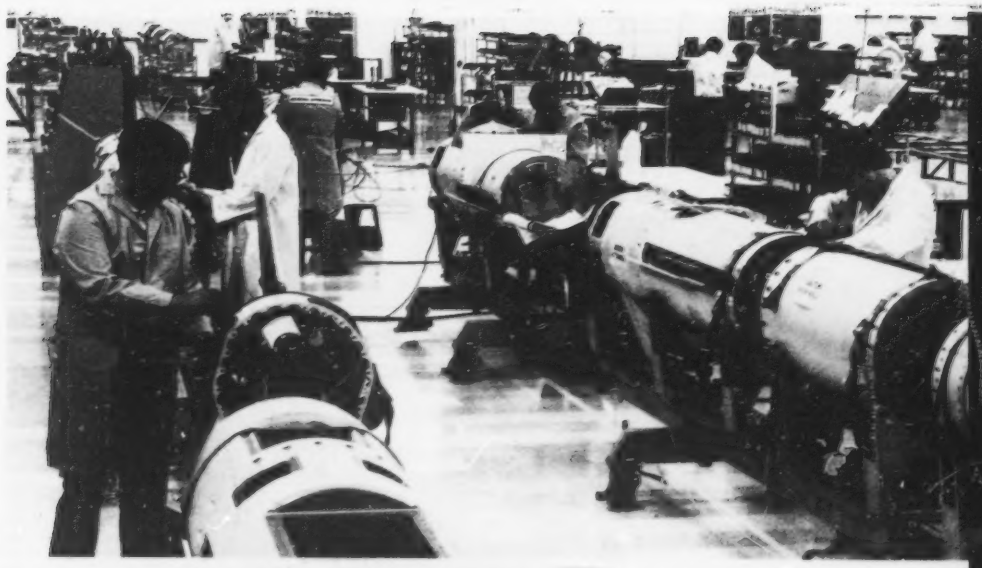
In a year-end development, production of the Peacekeeper (MX) intercontinental missile was stalled by a "lame duck" session of the 97th Congress. The Congress objected to the "dense pack" basing mode announced in November, under which 100 MX missiles would be emplaced in superhard silos in a narrow strip of Wyoming; the dense pack theory holds that spacing the silos only 1,800 feet apart would cause attacking warheads to detonate each other and thus afford high survivability for the MXs. In rejecting dense pack, the Congress deleted almost $1 billion for initial MX production and $500 million in R&D funding until the Administration submits—and Congress approves—a new basing plan. The President agreed to reconsider MX basing and to come up with new recommendations after March 1.

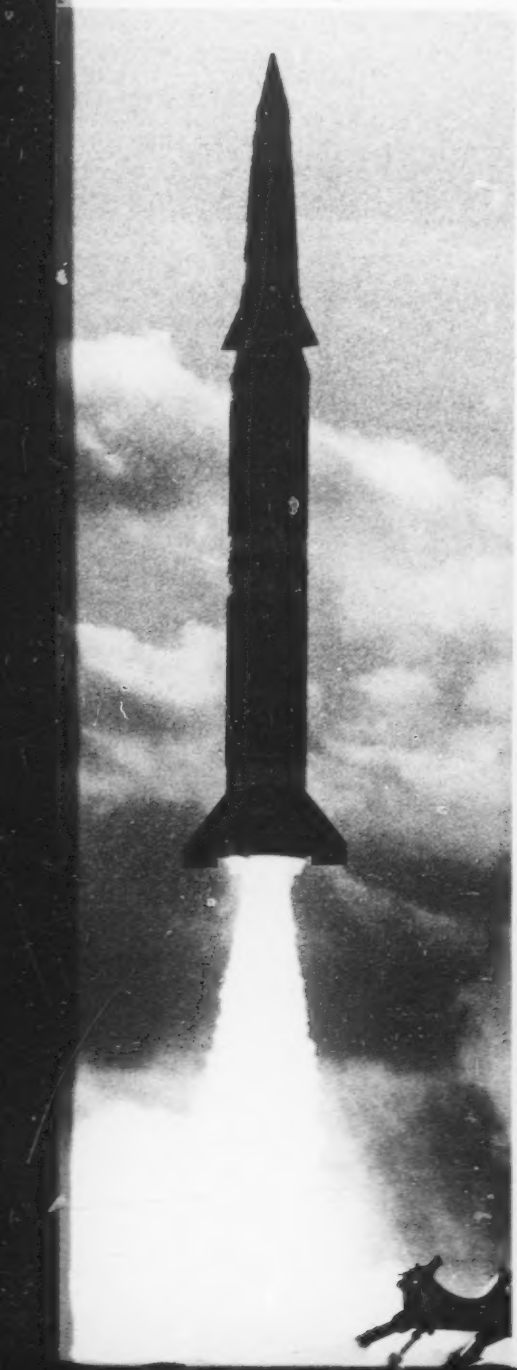
In the meantime, MX continues as an active project under a separate research and test allocation of $1.7 billion. In 1982, testing continued independently on the propulsion units for the four stages and the guidance/re-entry systems; first flight of a complete MX prototype was planned for early 1983. Major MX contractors include Martin Marietta Aerospace (assembly and test), Rockwell Autonetics (guidance and computers), Northrop (inertial guidance system), Morton Thiokol (first stage), Aerojet-General (second stage), Hercules Incorporated (third stage), Rockwell Rocketdyne (fourth stage), Avco Corporation (re-entry systems), Westinghouse (missile canister), Boeing (support equipment), TRW Inc. (engineering and technical support) and Honeywell Inc. (guidance and control elements).

The Navy's Trident 1 sea-launched ballistic missile advanced toward full operational status with readiness demonstrations—including actual launches—by the first two Trident-class nuclear-powered submarines. The *USS Ohio* completed its shakedown in January and became operational; the *USS Michigan* began readiness testing in January and was to become operational in 1983. Early in 1982, the Navy initiated development of the advanced Trident 2, planned for deployment in 1989.

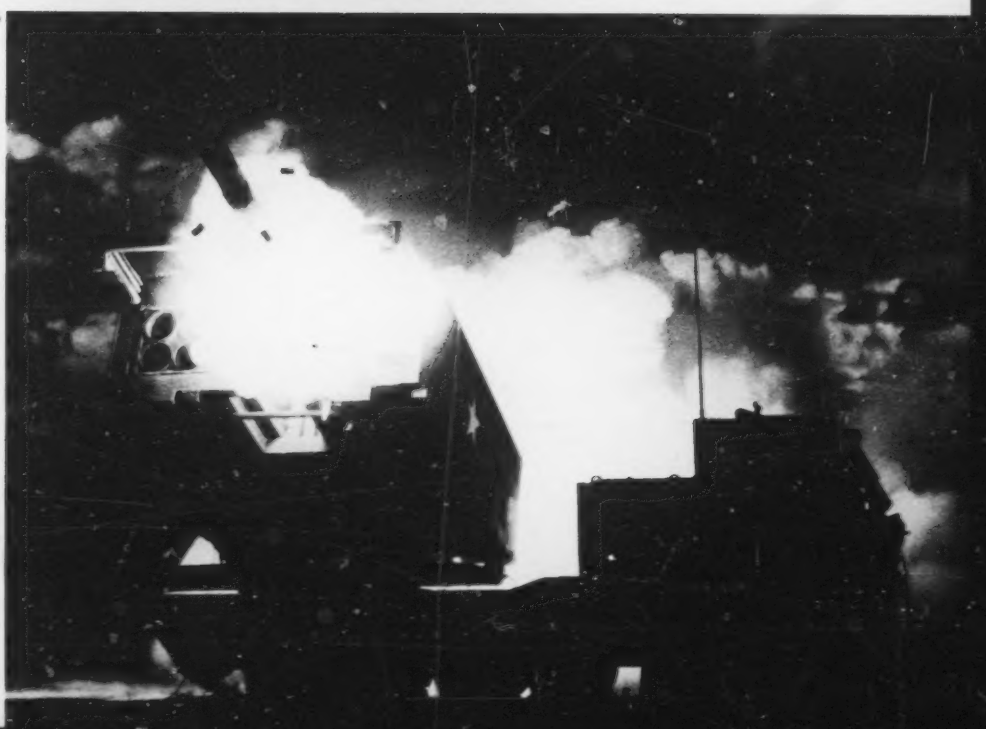
In June, the Department of Defense approved a production go-ahead for the Army/Martin Marietta Pershing 2 ballistic missile even though the weapon had not been flight tested; the go-ahead was necessary to meet the deployment schedule of December 1983. Pershing 2's initial test flight, in July, was a failure, but a second flight in November was a complete success.

General Dynamics' Tomahawk cruise missile continued in development in three separate programs: the USAF's Ground Launched Cruise Missile (GLCM), the Navy's Sea Launched Cruise Missile (SLCM) and the USAF's Medium-Range Air-to-Surface Missile (MRASM). In June, the GLCM made a fully-guided 800-mile flight, the fourth of eight development tests and the first launched by Air Force personnel. SLCM tests in 1982 culminated





1. The Navy's Trident 1 sea-launched ballistic missile became operational aboard the first Trident-class nuclear-powered submarine.
2. The Pershing 2 Army mobile ballistic missile made its first successful test flight in November.
3. Tomahawk cruise missiles are being built in three versions, including ground-launched, sea-launched and air-launched systems.
4. The Navy conducted the first overwater tests of the RAM shipboard defense system in October.
5. The Army took first deliveries of production versions of the Multiple Launch Rocket System in August; the system is to become operational in March 1983.



with a December launch from the submerged submarine *USS Guitarro*; the missile hit a simulated target 300 miles from the launch point. MRASM was in hardware fabrication status with initial flight testing planned for 1984. The Boeing-built Air Launched Cruise Missile was in production and in initial operational status with the Air Force.

In other 1982 missile developments:

- Hughes Aircraft Company was selected as prime contractor for development and production of the USAF/Navy Advanced Medium-Range Air-to-Air Missile (AMRAAM); Raytheon Company was named second production source. A prototype AMRAAM scored three successes in six test flights in the latter part of the year; tests of the full-scale development model were slated for 1984.
- The Air Force/Hughes Imaging Infrared Maverick air-to-surface missile completed a 26-flight development/operational test program in August and was ordered into pilot production in September. Also undergoing test was the Laser Maverick planned for Marine Corps use; in one April–July test series, the weapon scored 15 successes in 15 trials against a variety of land and sea targets.
- Vought Corporation began deliveries of production versions of the Army's Multiple Launch Rocket System in August. The first Army MLRS battery was scheduled to become operational in March 1983.
- In October, the Navy conducted the first overwater tests of the General Dynamics Rolling Airframe Missile (RAM), a shipboard defense system; drones simulating attacking anti-ship weapons were successfully intercepted.
- First production units of the Army/Raytheon Patriot long-range anti-aircraft missile system successfully destroyed high performance drones in October.
- Texas Instruments delivered the first High Speed Anti-Radiation (HARM) missiles to the Navy in December.
- The USAF conducted a series of unguided tests of the Hughes-built Wasp anti-armor missile, launched from an F-16 fighter, and late in the year initiated guided tests.

The year's highlight in military aircraft was the January start of production of the USAF/Rockwell International B-1B bomber. A target date of March 1985 was established for first delivery; the plan calls for 100 B-1Bs in service by 1988.

Other major military aircraft in production during 1982 included the USAF's F-15 fighter (McDonnell Douglas), F-16 fighter (General Dynamics), the A-10 attack aircraft (Fairchild Republic) and the C-5 heavy lift cargo carrier (Lockheed); the USAF/Navy A-7 attack bomber (Vought); the Navy F-14 fighter (Grumman) and the F-18 fighter (McDonnell Douglas). At year-end, a Department of Defense review board recommended production of the attack version of the F/A-18. In limited production were the Boeing E-3A Airborne Warning and Control System (AWACS) and the McDonnell Douglas KC-10 cargo/tanker aircraft.

In other military aircraft developments of 1982,

- The General Dynamics F-16XL, which features an advanced technology arrow wing for increased range/payload and greater penetration speed, made its first flight in July.
- The Air Force/General Dynamics AFTI F-16 technology demonstrator, which incorporates an advanced digital flight control system, made its flight debut in July.
- The Northrop F-20 Tigershark (formerly F-5G) started its flight test program in August; it is a low-cost, high-performance military fighter intended for the export market.
- The USAF Defense Advanced Research Projects Agency Grumman-built X-29A, which incorporates a forward-swept wing and other innovations, progressed toward first flight early in 1984.
- In May, Boeing Vertol delivered the first CH-47D Chinook tandem-rotor transport helicopter to the Army; production of 436 Chinooks is planned.
- In November, Bell Helicopter Textron delivered to the Navy the first of 55 TH-57 helicopter instrument trainers.
- The Army/Hughes AH-64 helicopter gunship essentially completed development testing; production start was scheduled for 1983.
- In December, the USAF took delivery of the first five of its Sikorsky-built UH-60As, rescue versions of the Army's Black Hawk assault helicopter. At year-end, Sikorsky was developing two prototypes of the HH-60D Night Hawk, to be used by the Air Force for combat rescue and unconventional warfare missions; first flight was planned for 1984.

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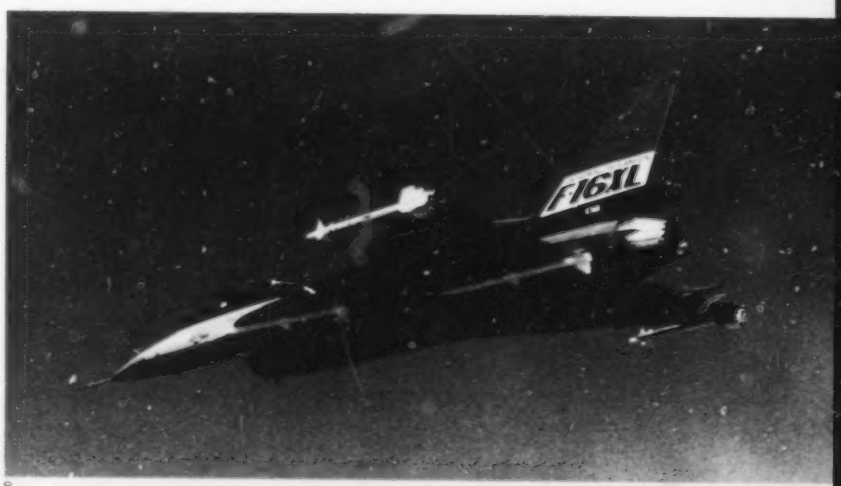
6. Production of the USAF's B-1B bomber began in January.
7. The F-20 Tigershark, a military fighter intended for the export market, made its first flight in August.
8. Featuring an advanced technology arrow wing, the F-16XL successfully completed its initial flight in July.
9. In development and targeted for first flight in 1984 is the USAF/Defense Advanced Research Projects Agency X-29A.
10. In May, Boeing Vertol delivered the first CH-47D Chinook transport helicopter to the Army.



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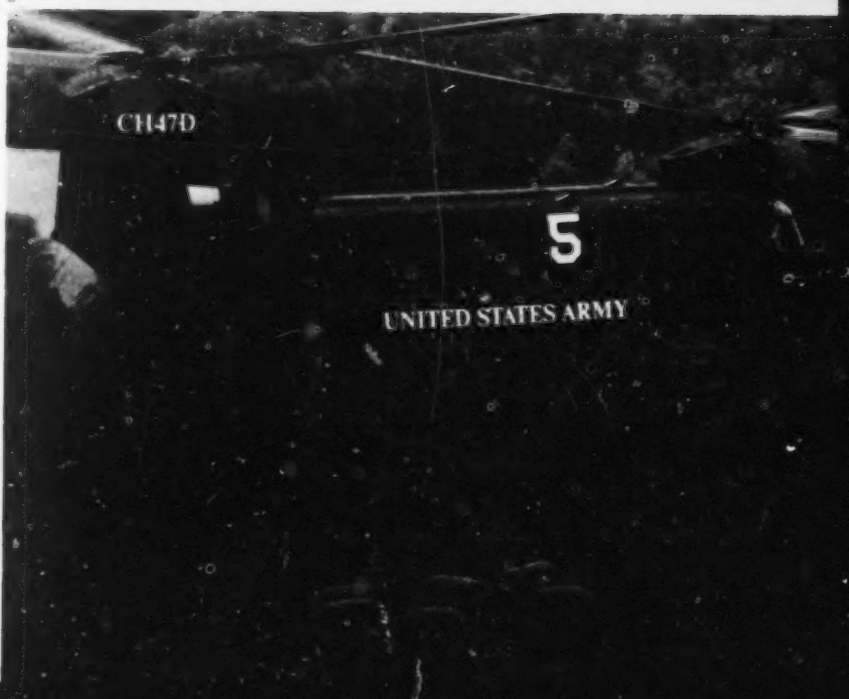

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Space

For the National Aeronautics and Space Administration, 1982 was highlighted by the operational debut of the Space Shuttle and a perfect launch record for the year—12 successes in 12 flights.

In March and June, missions STS-3 and STS-4 completed the four-flight orbital test program of the Space Shuttle. In November, the Shuttle made its first operational flight (STS-5), delivering two commercial communications satellites, both built by Hughes Aircraft Company: the third of the Satellite Business Systems satellites (SBS-3) and a fourth Anik spacecraft for the Telesat Canada network. The two satellites were deposited in low Earth orbit by the Orbiter *Columbia*—SBS-3 on November 11 and Anik a day later—then boosted to their geosynchronous operational altitude (22,300 miles) by a McDonnelll Douglas PAM-D upper stage; it marked the first Shuttle use of the PAM booster.

On July 4, hours after *Columbia* completed its fourth flight, the second Orbiter, *Challenger,* was delivered to Kennedy Space Center for checkout and payload installation prior to its debut on STS-6 early in 1983. NASA planned five Shuttle flights in 1983, including the first Spacelab mission (STS-9) in October. Principal contractors for the Space Shuttle are Rockwell International (prime contractor and Orbiter manufacturer), Morton Thiokol Corporation (solid rocket boosters) and Martin Marietta Aerospace (external fuel tank).

In addition to the three Shuttle flights, NASA used its McDonnell Douglas Delta and General Dynamics Atlas Centaur expendable vehicles to launch nine satellites, eight of them commercial communications satellites launched on a reimbursable basis. The list included two spacecraft of the RCA Satcom system, built by RCA Astro-Electronics; two Ford Aerospace Intelsat Vs for the global network operated by the International Telecommunications Satellite Organization; two Hughes-built Westars, the fourth and fifth of the Western Union system; the third Telesat Canada Anik, also built by Hughes; and Insat 1, built by Ford Aerospace, the first spacecraft of the Indian National Satellite System.

The lone NASA launch of the year was Landsat-4 on July 16. Built by General Electric Company's Space Systems Division, Landsat-4 is an advanced member of the Earth resources monitoring satellite family; a new thematic mapper in Landsat-4 provides greater clarity of detail in remotely-sensed data than was possible with earlier Landsats.

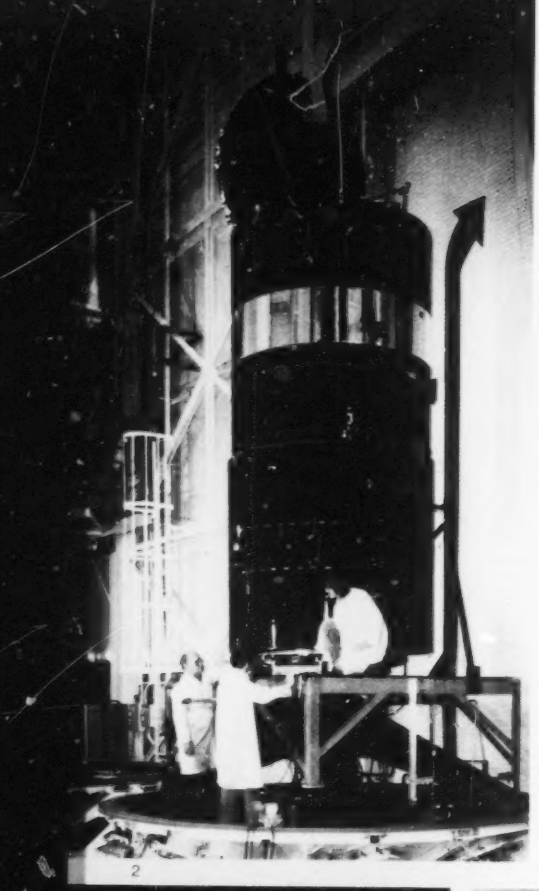
Being readied for launch at year-end was the Infrared Astronomical Satellite (IRAS), a scientifically important system that will conduct a systematic survey of a million infrared sources in the universe. IRAS is built and managed by Jet Propulsion Laboratory.

In another 1982 development, NASA "re-launched" a satellite already in orbit. Goddard Space Flight Center controllers nudged the International Sun/Earth Explorer 3 out of its orbit into a new path that will take it to a late 1985 encounter with the Comet Giacobini-Zinner. The mission will provide valuable information for encounters by spacecraft of other nations with Comet Halley in 1986; the ingenious plan gave NASA a foot in the door for 1985/86 comet studies after funding for a NASA Comet Halley mission was denied.

A non-NASA civil space event of 1982 was the September 9 successful launch and suborbital flight of the Conestoga 1 launch vehicle, privately developed as a commercial venture by Space Services, Inc.

In planetary exploration, NASA's Voyager 2 continued on a trajectory that will take it to a 1986 encounter with the planet Uranus and

1. Second of NASA's four Shuttle Orbiters, the *Challenger* was delivered to Kennedy Space Center in July.
2. The fourth Canadian Anik communications satellite was one of two satellites launched on the first operational mission of the Space Shuttle.
3. STS-5, the first operational Shuttle flight, also marked the Shuttle debut of the PAM-D Payload Assist Module, an upper stage booster. In the photo, the PAM propulsion unit and its payload—the third Satellite Business System spacecraft—pop out of the clamshell sunshield that protects them from the intense heat and cold in the open cargo bay of the Shuttle Orbiter.
4. NASA initiated a series of study contracts for a permanent manned space station in low Earth orbit. Representative of concepts being developed by eight major contractors is this Boeing multi-man station.
5. In July, NASA launched Landsat-4, an advanced version of the Landsat Earth resources monitoring series of satellites.
6. Shown undergoing pre-launch testing, the first of a new DSCS III series of defense communications satellites was launched in November.



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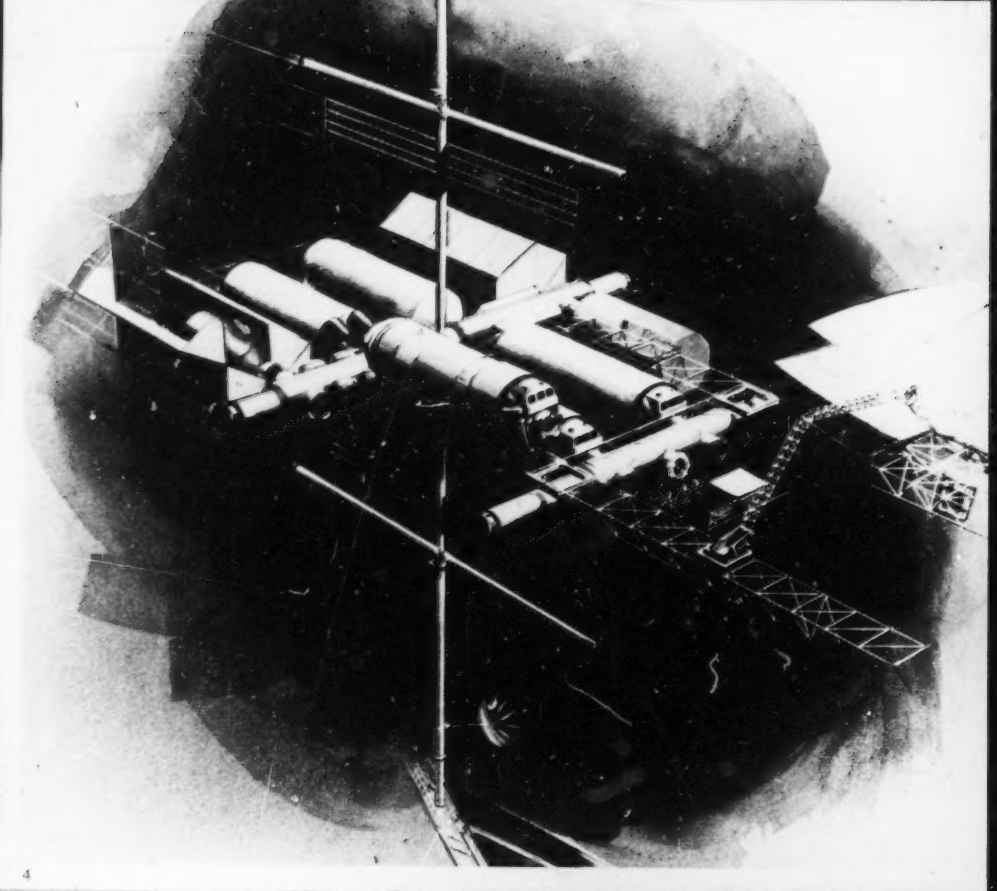

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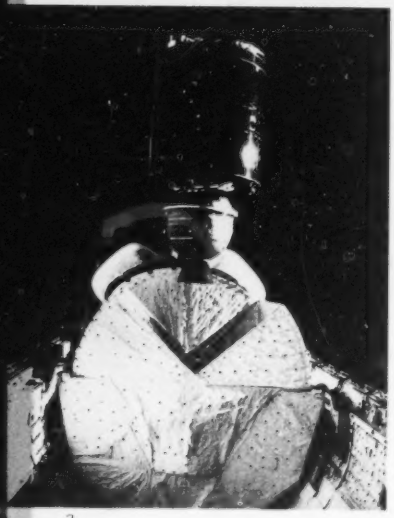

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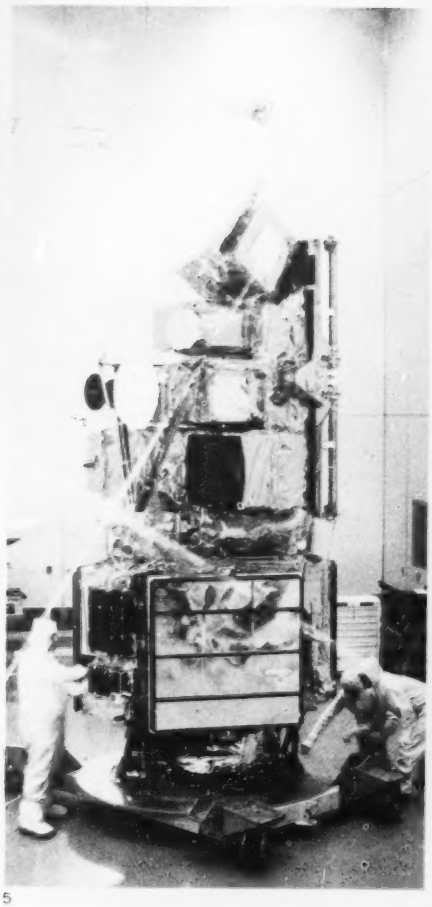

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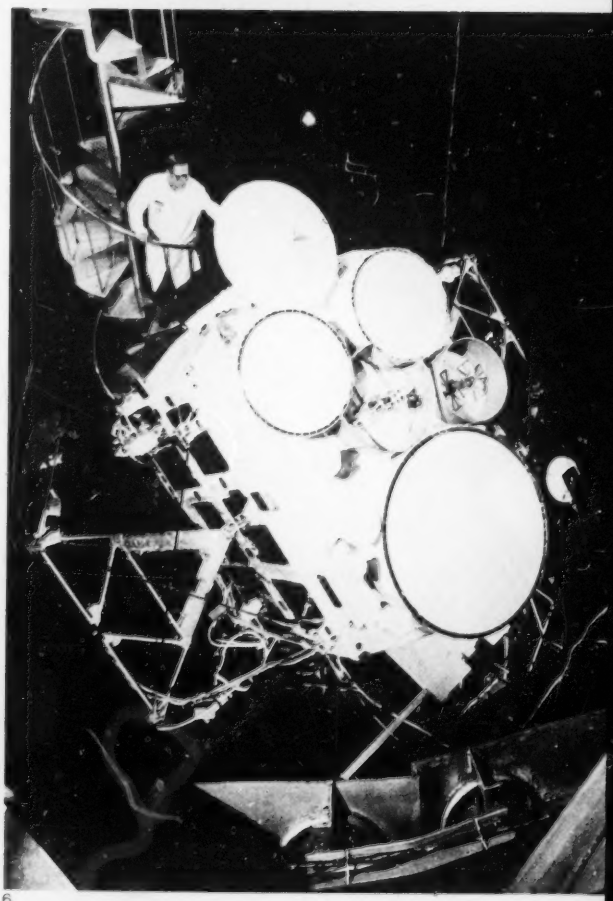

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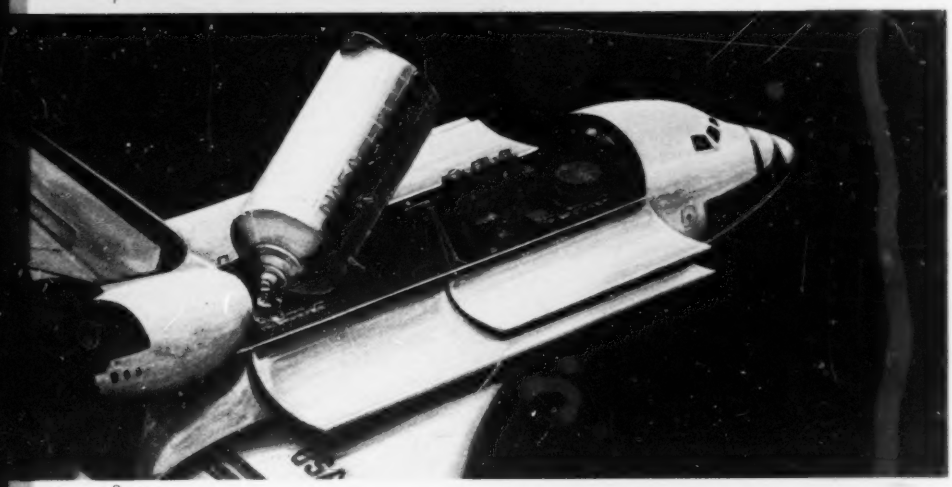
7. The USAF's first GEODSS deep space surveillance system, which can spot a soccer-ball-size object at 22,000 miles, became operational in May, followed by two other stations later in the year; a five-station network is planned.

8. In development for service beginning in 1987 is the Solar Optical Telescope, a reusable system that will operate from the cargo bay of the Shuttle Orbiter.



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a 1989 rendezvous with Neptune. The NASA/Hughes Pioneer Venus Orbiter continued to orbit Venus and relay data and, on Mars, Viking Lander 1—the sole survivor of four Martin Marietta-built Viking spacecraft—was still sending weekly reports after more than six years of service on the Red Planet.

With the Space Shuttle operational, NASA's research and development focus shifted to plans for a permanent manned space station in low Earth orbit. In 1982, NASA awarded a series of space station study contracts, including broad conceptual studies and more detailed studies of specific missions that could be accomplished with an orbital platform. Major contractors include Rockwell International, General Dynamics, Boeing Aerospace, Grumman, McDonnell Douglas Astronautics, Martin Marietta, Lockheed Missiles & Space and TRW Inc. NASA's plan calls for continuing studies in 1983/84 leading to program definition and the start of hardware development in 1985/86. If approved and funded, the initial space station could be in orbit by 1990.

Other NASA programs in development included:

• Galileo, to be Shuttle-launched in 1985, a project involving two spacecraft, one a long-term orbiter of the planet Jupiter, the other a probe to descend through the planet's atmosphere. Hughes Aircraft is probe contractor.

• The Space Telescope, an orbiting observatory capable of peering to the edge of the universe and expanding man's view of the cosmos 350 times. Lockheed Missiles & Space Company is prime contractor for the spacecraft, Perkin-Elmer Corporation for the optical assembly.

• The Solar Optical Telescope, designed to operate within the Shuttle Orbiter's payload bay, thus allowing reusability. Intended for service beginning in 1987, it is being developed by Perkin-Elmer Corporation.

• The Advanced Communications Technology Satellite, designed to ease orbital communications congestion by allowing use of a new frequency band and making more efficient use of existing bands. Hardware go-ahead is expected in 1983; study contractors include Hughes, TRW, Motorola and Ford Aerospace.

• Planned for 1988 launch, the Gamma Ray Observatory will study how gamma rays are produced and where they come from; TRW is principal contractor.

• The Cosmic Background Explorer, the first satellite designed specifically to investigate details of the "Big Bang," the colossal explosion believed to have marked the beginning of the universe; it will be launched in the latter 1980s.

• The 11-ton Advanced X-ray Astrophysics Facility, which will have instruments with about 100 times the sensitivity of prior x-ray spacecraft to provide information on the forces involved in the creation of stars, galaxies, quasars and black holes.

• The Earth Radiation Budget Explorers, a two-spacecraft team being developed by Ball Aerospace to investigate how energy from the Sun is distributed throughout Earth's environment; it will be launched late in this decade.

• The Upper Atmosphere Research Satellite, intended for late eighties launch, which will make global observations of the upper atmosphere's chemical composition and study, in particular, how human activities affect the ozone layer.

The military space program continued to grow rapidly. In fiscal year 1982, military space funding topped NASA's for the first time and will be substantially greater than NASA's in 1983. Although details are classified, the Department of Defense is generally replacing existing communications, weather and intelligence-gathering satellites with more advanced systems; introducing some new space systems, such as the Space Shuttle and the Navstar navigation network; and developing advanced capabilities in space weaponry, missile attack warning, communications security and spacecraft survivability. Among unclassified developments of 1982,

• The Air Force initiated a development program for the Milstar extremely high frequency communications satellite intended for service late in the decade. Competing contractor teams include Hughes/TRW and Ford Aerospace/Boeing/Lockheed/General Electric.

• In May, the first GEODSS (Ground-based Electro-optical Deep Space Surveillance System) installation became operational at White Sands Missile Range, New Mexico; two other stations were activated later in the year, in Hawaii and South Korea. Built by TRW, each GEODSS system consists of three video-equipped 40-inch telescopes capable of spotting an object the size of a soccer ball at an altitude of 22,000 miles. The system's job is to track and indentify all spacecraft in Earth orbit. Two additional stations are planned at sites in the Indian Ocean and in the eastern Atlantic.

• In November, the Air Force launched the first Boeing-built Inertial Upper Stage (IUS) aboard a Titan launch vehicle; the IUS performed almost flawlessly, setting the stage for its first Shuttle use in 1983.

• The IUS boosted a pair of communication satellites, one of them the first of the DSCS III series of the advanced Defense Satellite Communications System, built by General Electric; the other was a TRW-built DSCS II, the 15th of the series.

• In December, the Air Force launched the first of a new, improved Block 5D-2 spacecraft series in the Defense Meteorological Satellite Program; four more 5D-2 satellites, built by RCA Astro-Electronics, are scheduled for launch in 1983–85.

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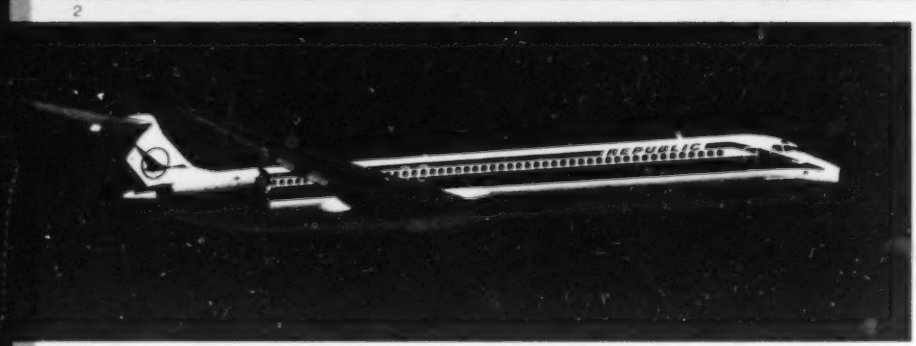

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1. United Air Lines inaugurated service with the Boeing 767 in September.
2. The Boeing 757 made its first flight in February and was certified by the Federal Aviation Administration in December.
3. In September, McDonnell Douglas received certification for the advanced technology DC-9 Super 80.

Civil Aviation

Despite the recession, passenger traffic on U.S. scheduled airlines was up in 1982, but financially it was another troubled year for the carriers. The industry's operating revenue was expected to fall below 1981's $37 billion, the first such annual decline in history.

On the basis of preliminary figures, the Air Transport Association estimated a traffic gain over 1981 of three to four percent—meaning about 10 million more passengers to a total of approximately 295 million. But, due to such factors as the poor U.S. economy, ticket price wars, high fuel costs and continuing disruptions occasioned by the 1981 controllers' strike, the industry anticipated an operating loss of $400–500 million in 1982—probably something close to the record 1981 loss of $420 million.

On the optimistic side, ATA cited factors "pointing to a possible positioning for an airline economic recovery beginning in 1983." The airlines have taken a number of steps to reduce costs and improve efficiency, such as route restructuring and the use of more fuel-efficient aircraft. Labor expenses are down and fuel prices, though still high, are declining; jet fuel dropped six cents a gallon in 1982 and that meant a saving of about $600 million. Additionally, traffic is expected to increase again in 1983, possibly to a level higher than the record 317 million passengers flown in 1979.

The airlines' financial straits continued to impact the aerospace manufacturing industry through reduced orders for new planes. At the end of September 1982, U.S. airlines had 457 aircraft on order and option valued at $14.7 billion; that compares with 719 aircraft worth $22.1 billion at the end of 1980. Annual deliveries of new transport have declined steadily: 160 in 1979, 147 in 1980, 121 in 1981, down to 102 in 1982. The trend will continue in 1983 with only 93 deliveries.

In the commercial transport manufacturing segment of the aerospace industry, a highlight of the year was the September

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4. McDonnell Douglas initiated design work on the DC-9 Super 90, a shortened 100–120 passenger version of the Super 80.

5. In June, Pan American Helicopter Airlines started airport-to-downtown service in New York with the Bell 222 transport.

6. Boeing Vertol delivered the last of six Model 234 44-passenger transports to British Airways Helicopters. In the photo, a BAH Model 234 is pressed into special service, retrieving a commuterliner after a forced landing.

7. Deliveries of the Sikorsky S-76 neared 200 at year-end; the helicopter was in service with 69 operators.

8. The NASA/Army/Bell XV-15 Tilt Rotor Research Aircraft approaches for a landing on the carrier *USS Tripoli* in one of a 1982 series of civil/military operational demonstrations.

9. NASA completed the initial test phase of the Sikorsky Rotor Systems Research Aircraft program and began an advanced series of flight tests.

10. Shown undergoing pre-commissioning flight inspection, a Bendix-built Microwave Landing System at Valdez, Alaska became—in November—the first MLS unit approved for instrument operations.

service introduction—by United Air Lines—of the Boeing 767 advanced twinjet. American Airlines and TWA began service in November. In December, Boeing made the first 767 delivery to a customer outside North America—China Airlines, which initiated service on January 1.

The companion Boeing 757 made its first flight in February and received Federal Aviation Administration certification in December; the first delivery was to Eastern Air Lines in December. Late in the year, Boeing started certification testing of a new derivative airplane, the 747-300, which features a stretched upper deck; deliveries were scheduled to start in March 1983. Boeing also initiated another derivative project, the 737-300; fabrication was under way at year-end and first flight was targeted for March 1984.

In September, McDonnell Douglas received certification for the advanced technology DC-9 Super 80. In an industry innovation, the company signed agreements with American Airlines and TWA for lease, rather than purchase, of 20 and 15 Super 80s respectively. McDonnell Douglas also started design work on a new DC-9 Super 90, which would have the advanced technology features of the Super 80 but a shorter fuselage accommodating 100–120 passengers; the company envisions a need for this size airplane about 1986.

U.S. commercial aircraft manufacturers delivered 233 aircraft in 1982, down sharply from 1981's 387; their dollar value was $6.4 billion, down from $9.7 billion in the preceding year. Sales of U.S.-built civil helicopters totaled 637 units worth $398 million; the comparable figures for 1981 were 1,072 helicopters valued at $597 million.

In 1982 rotary wing activity,

- Bell Helicopter Textron received certification for its 214ST SuperTransport from the FAA, the British Civil Aviation Authority and the Canadian Department of Transportation. In June, the Bell 222 transport began operating with Pan Am Helicopter Airlines on scheduled service between Kennedy International Airport and Pan Am's Metroport in downtown New York. In September, a Bell LongRanger flown by Ross Perot, Jr. and Jay Coburn completed the first round-the-world helicopter flight.
- Boeing Vertol completed deliveries to British Airways Helicopters of six 44-passenger Model 234 transport helicopters. The company was planning deliveries to two other customers—Arco Alaska, Inc. and Norway's Helikopter Services—early in 1983.
- Production of the Sikorsky S-76 twin-turbine transport continued. By year-end, there were 198 S-76s in service with 69 operators; 55 of the S-76s were in corporate service, 33 were flying in government/utility operations and 110 were engaged in support of offshore oil operations.

In civil aircraft research, the NASA/Army XV-15 Tilt Rotor Research Aircraft, which has both civil and military potential as a short-haul transport, was in advanced flight test status. The XV-15, built by Bell Helicopter Textron, made a series of operational demonstrations during the year, including landings on the Navy aircraft carrier *USS Tripoli*. Bell joined forces with Boeing Vertol for further development of both civil and military applications of the tilt rotor vehicle.

NASA continued flight testing of the Sikorsky-built Rotor Systems Research Aircraft, a flying laboratory for investigation of various rotors applicable to either helicopters or compound helicopters. The RSRA completed the initial phase of its testing, involving detailed measurements of aerodynamic loads on rotor and fuselage in hovering and low speed flight. Ames Research Center started to check out different rotor systems over a wide range of operating conditions. Ames was also conducting advanced flight tests of the Boeing-built Quiet Short-haul Research Aircraft, designed to demonstrate the propulsive lift concept that may enable tomorrow's short-haul transports to

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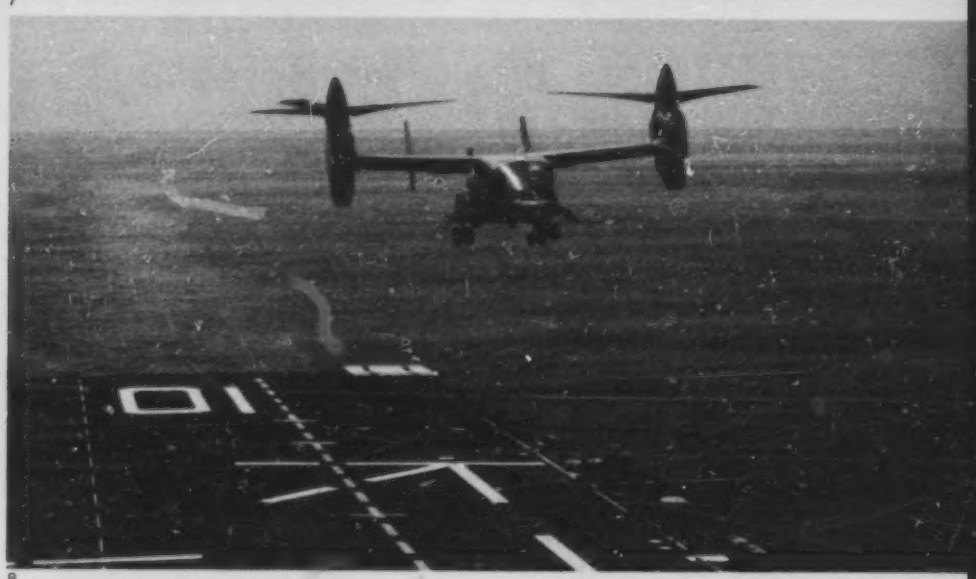

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operate from very short runways.

The Federal Aviation Administration, while rebuilding the air traffic control system in the wake of the 1981 controllers' strike, was also laying the foundation for the future system. FAA was engaged in an across-the-board effort aimed at modernizing the air traffic control/air navigation physical plan, overhauling and simplifying the air structure, and expanding airport capacity at major terminals.

FAA published the National Airspace System plan, a 450-page document that spells out in detail the measures FAA intends to take to upgrade the entire system. Approved by Congress, the plan includes replacement of the current air traffic control computer system; the automation and consolidation of FAA's network of more than 300 flight service stations; the implementation of Mode S, a new secondary radar system that paves the way for automatic data link air-to-ground communications; a major upgrading of weather services; and installation of the new Microwave Landing System (MLS) at major airports. In November, a unit at Valdez, Alaska became the first MLS system to be commissioned for instrument operation. The unit was built by Bendix Communications Division, a principal developer of MLS airborne and ground equipment.

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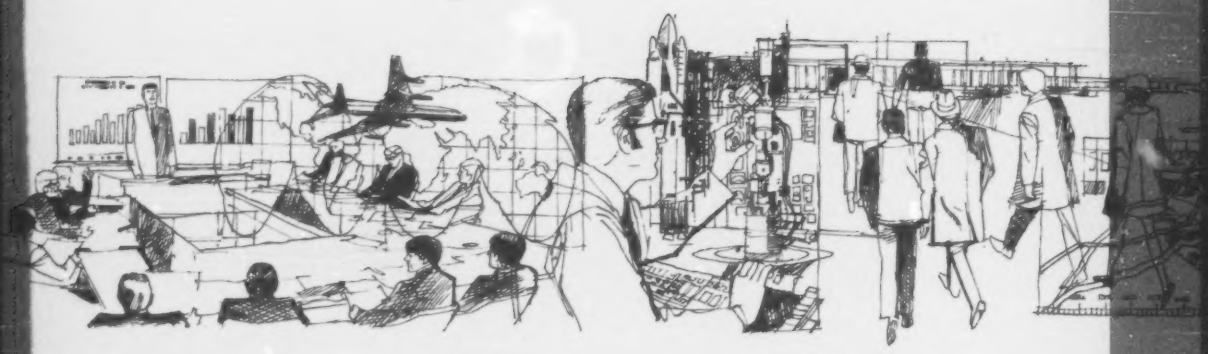
AEROSPACE REVIEW AND FORECAST 1982/1983



In 1982, the aerospace industry's sales dropped below the previous year's level, the first such decline in a decade. The decline was due to a sharp plunge in civil aircraft sales that more than offset gains in military and space business. Decreased civil aircraft sales also had marked effect on the industry's exports and trade balance, both of which dipped in 1982 after five years of record-setting performance.

Here is a summary of the aerospace year 1982 based on preliminary data:

Sales. Total industry sales amounted to $63.3 billion, compared with $65.3 billion in 1981. Although the reduction is small in current dollar terms, it represents a decline of 6.7 percent after adjustment for inflation.

Sales of civil aircraft fell by 40 percent in real (inflation-adjusted) terms; at $11.2 billion, civil sales were $6.2 billion below the 1981 level. Sales of military aircraft increased from $19.2 billion in 1981 to $22.8 billion in 1982. Space sales, civil and military combined, increased to $10.9 billion from $9.5 billion in the previous year, and missile activity, at $7.9 billion, was up $1.1 billion. Sales of non-aerospace products, $10.6 billion in 1982, remained at the previous year's level.

Backlog. Orders on the industry's books at year-end 1982 totaled $95.3 billion, up $1 billion from year-end 1981. Of the total, $51.3 billion was in orders from the U.S. government and $44 billion was in non-government orders. However, the Bureau of the Census is adjusting backlog data and it is probable that these figures will be revised downward.

International Trade. Demand for U.S. aerospace products abroad remained strong, but aerospace exports fell far short of the previous year's all-time high. Exports dropped from $17.6 billion in 1981 to $15.2 billion in 1982. Aerospace imports remained at exactly the previous year's level, $4.5 billion. The aerospace balance of trade was $10.7 billion, down from 1981's record $13.1 billion.

Earnings. The industry's profit after taxes declined 23 percent, from $3 billion in 1981 to $2.3 billion in 1982. The profit rate, measured as a percentage of sales, was 3.3 percent, down from 4.4 percent in 1981. Foremost among several factors contributing to the lower profit was the much higher ratio—almost two to one—of military sales to commercial sales; historically, military sales have yielded lower profit.

Plant and Equipment. Aerospace industry expenditures for new plant and equipment dipped to $6 billion, compared with $6.4 billion in 1981. A number of economic factors, such as business uncertainty, high interest rates and declining profit margins, influenced the decline.

Employment. Industry employment dropped below the previous year's total. At year-end 1982, the work force totaled 1,162,000, down from 1,203,000 at the end of 1981. The drop was due to declining production levels in civil aircraft manufacture.

FORECAST

Aerospace Industries Association projects a 1983 sales rebound, due largely to anticipated increases in military research, development and production activities. However, the projected sales increase is considerably smaller than those experienced in 1979-81.

For 1983, overall industry sales are estimated at $69.3 billion, which would represent sales growth in real terms of slightly less than three percent. This compares with 10 percent growth in each of the two years prior to 1982.

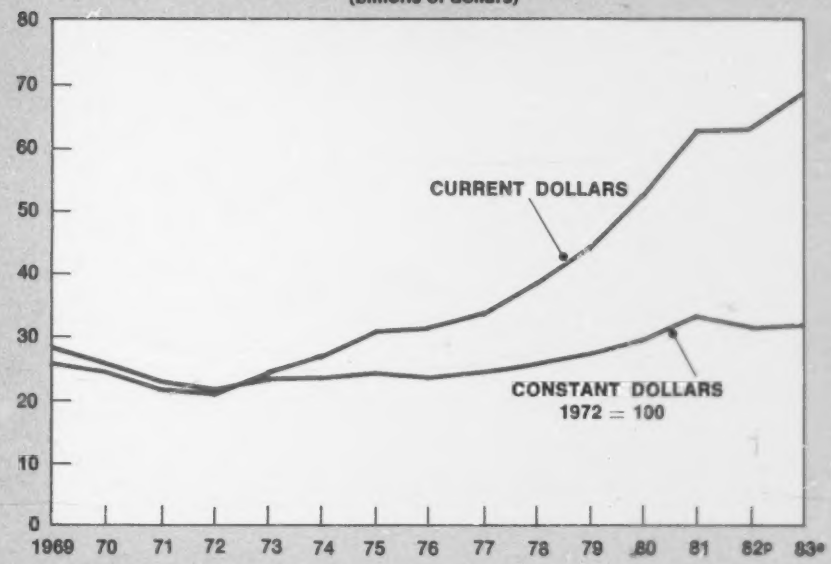
Industry employment is expected to rise 23,000 to 1,185,000 by year-end 1983.

Defense. AIA estimates that sales of aerospace products to the Department of Defense will reach $34.8 billion in 1982; that's an increase of more than 11 percent over 1982, with gains in all categories—aircraft, engines and parts, missiles and space. For the years beyond 1983, the Administration's defense buildup plan, even if somewhat modified by Congressional funding reductions, indicates high levels of aerospace industry activity for the next several years.

Space. In fiscal year 1982, military funding for space topped NASA's funding for the first time, a reflection of the rapidly growing military space program, expenditures for which—as projected by the Administration—will far outstrip NASA outlays in FY 1983 and near-future years. In civil space, NASA funding is expected to continue at or near the current level through the mid-1980s. There is potential for enormous growth in commercial space business, particularly in fabrication of communications satellites; experts are estimating launch of 350 comsats between now and the year 2000, and the estimate is considered conservative. With big increases in military and non-NASA civil space business, the industry's space workload bids to become a more significant portion of total sales in the 1980s. For 1983, AIA estimates space sales at $12.5 billion, up more than 12 percent.

Civil Aircraft. On the basis of backlog figures, AIA estimates civil aircraft sales in 1983 at $11.4 billion, up only $200 million—meaning a decline in inflation-adjusted terms. Transport aircraft constitute by far the largest element of the industry's civil aircraft sales and manufacturers estimate the transport market at $110-120 billion over the next decade; the question is when the financial health of the world's airlines will permit them to resume aircraft orders. The answer hinges largely on a turnaround in the world economy.

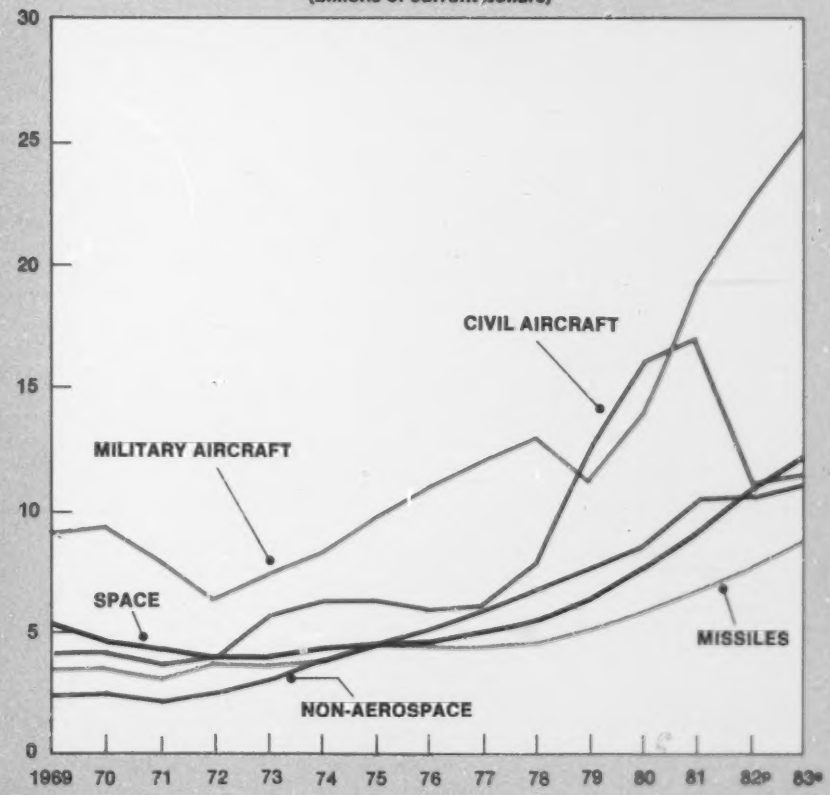
AEROSPACE INDUSTRY SALES
(billions of dollars)



Source: Aerospace Industries Association
p Preliminary
e Estimate

The aerospace industry's 1982 total sales of $63.3 billion included $52.8 billion in sales of aerospace products and services, plus $10.5 billion in non-aerospace sales. The Department of Defense predominates in a breakdown of aerospace sales by customer; DoD sales amounted to $30.9 billion, while sales to NASA and other government agencies totaled $4.9 billion. Commercial sales of aerospace products and services totaled $17 billion, a drop of more than $5.3 billion and the first such decline since 1976. For 1983, Aerospace Industries Association projects total sales of $69.3 billion, $58.2 billion in aerospace sales and $11.1 for non-aerospace.

AEROSPACE INDUSTRY SALES BY PRODUCT GROUP
(billions of current dollars)

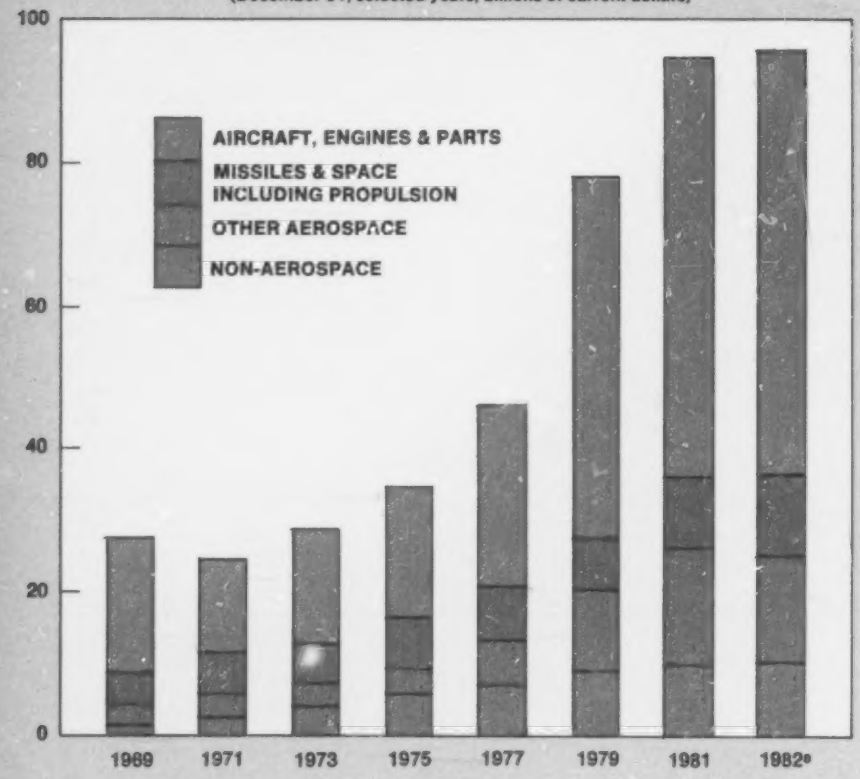


Source: Aerospace Industries Association
p Preliminary
e Estimate

As is customary, aircraft production represented the largest single element of the 1982 sales volume—54 percent. Sales of military aircraft topped civil aircraft sales by a wide margin, increasing by more than 18 percent while civil aircraft sales fell to their lowest level since 1978. In 1983, military aircraft sales are expected to grow by more than 11 percent while civil aircraft sales remain at approximately the 1982 level.

AEROSPACE INDUSTRY BACKLOG, BY PRODUCT GROUP

(December 31, selected years; billions of current dollars)



Source: Aerospace Industries Association, based on data from the U.S. Department of Commerce and AIA estimates.

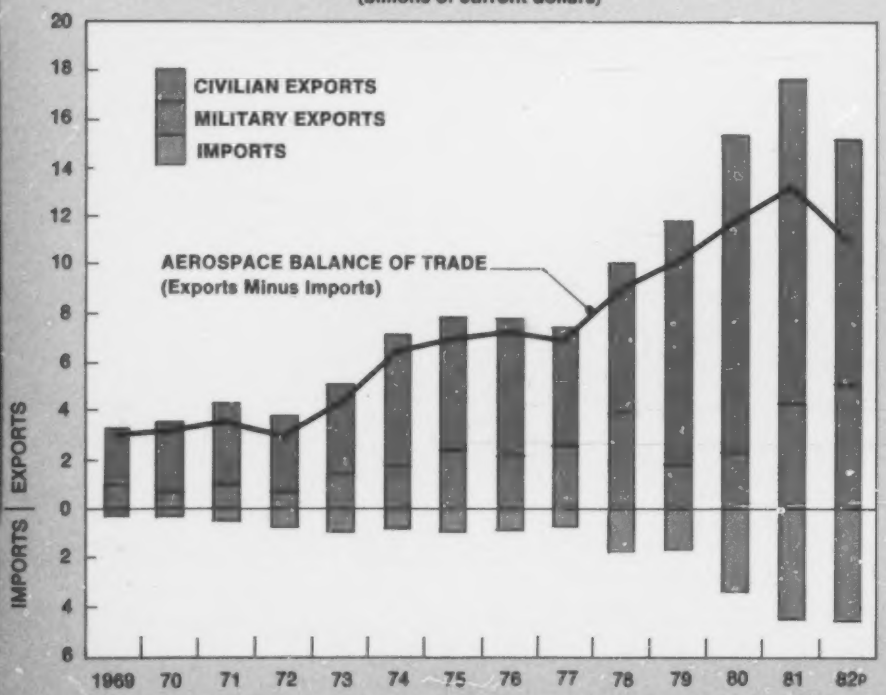
e Estimate

The aerospace industry's backlog of orders at year-end 1982 was $95.3 billion, up slightly more than one percent over the $94.3 billion on the books at the end of the previous year. Orders from the U.S. government ($51.3 billion) topped orders from other customers ($44 billion) for the first time since 1978.

Orders for aircraft, engines and parts constituted 61 percent of the total backlog. A breakdown of other backlog shows about 15 percent for "other aerospace" products and roughly 12 percent each for missiles/space and non-aerospace products.

AEROSPACE EXPORTS, IMPORTS, AND TRADE BALANCE

(billions of current dollars)



Source: Aerospace Industries Association, based on data from the U.S. Department of Commerce and AIA estimates.

p Preliminary

The 1982 aerospace export volume dropped to $15.2 billion from 1981's $17.6 billion due to a sharp decline in civil aircraft sales abroad. Civil exports, however, remained the largest element of the export volume at $10 billion, or about two-thirds of the total. Military exports showed a rise of almost $1 billion to a record level of $5.3 billion.

Aerospace imports, at $4.5 billion, remained at exactly the previous year's level. The largest single element of the import volume was general aviation airplanes. After four record-setting years, the aerospace balance of trade fell from $13.1 billion in 1981 to $10.7 billion in 1982.

CIVIL AIRCRAFT SHIPMENTS

1968-1983

	NUMBER OF AIRCRAFT SHIPPED				VALUE (Millions of Dollars)			
Year	TOTAL	Commercial Transport Aircraft[a]	Helicopters	General Aviation	TOTAL	Commercial Transport Aircraft[a]	Helicopters	General Aviation
1968	14,922	702	522	13,698	$ 4,267	$3,789	$ 57	$ 421
1969	13,505	514	534	12,457	3,598	2,939	75	584
1970	8,076	311	482	7,283	3,546	3,158	49	339
1971	8,158	223	469	7,466	2,984	2,594	69	321
1972	10,576	227	575	9,774	3,308	2,660	90	558
1973	14,709	294	770	13,645	4,665	3,718	121	826
1974	15,326	332	828	14,166	5,091	3,993	189	909
1975	15,251	315	864	14,072	5,086	3,779	274	1,033
1976	16,429	222	757	15,450	4,592	3,078	285	1,229
1977	17,913	155	848	16,910	4,451	2,949	251	1,551
1978	18,962	241	904	17,817	6,458	4,308	328	1,822
1979	18,450	376	1,019	17,055	10,644	8,030	403	2,211
1980	13,634	387	1,366	11,881	13,058	9,895	656	2,507
1981	10,916	387	1,072	9,457	13,223	9,706	597	2,920
1982[p]	5,020	233	637	4,150	8,631	6,383	398	1,850
1983[e]	5,509	221[b]	788	4,500	9,421	6,882[b]	539	2,000

Source: Aerospace Industries Association, based on company reports, data from the General Aviation Manufacturers Association, and AIA estimates.

a Includes all U.S. manufactured civil jet transport aircraft plus the turboprop-powered Lockheed L-100.

b Includes 29 DC-9 transport aircraft to be shipped under lease agreements.

p Preliminary.

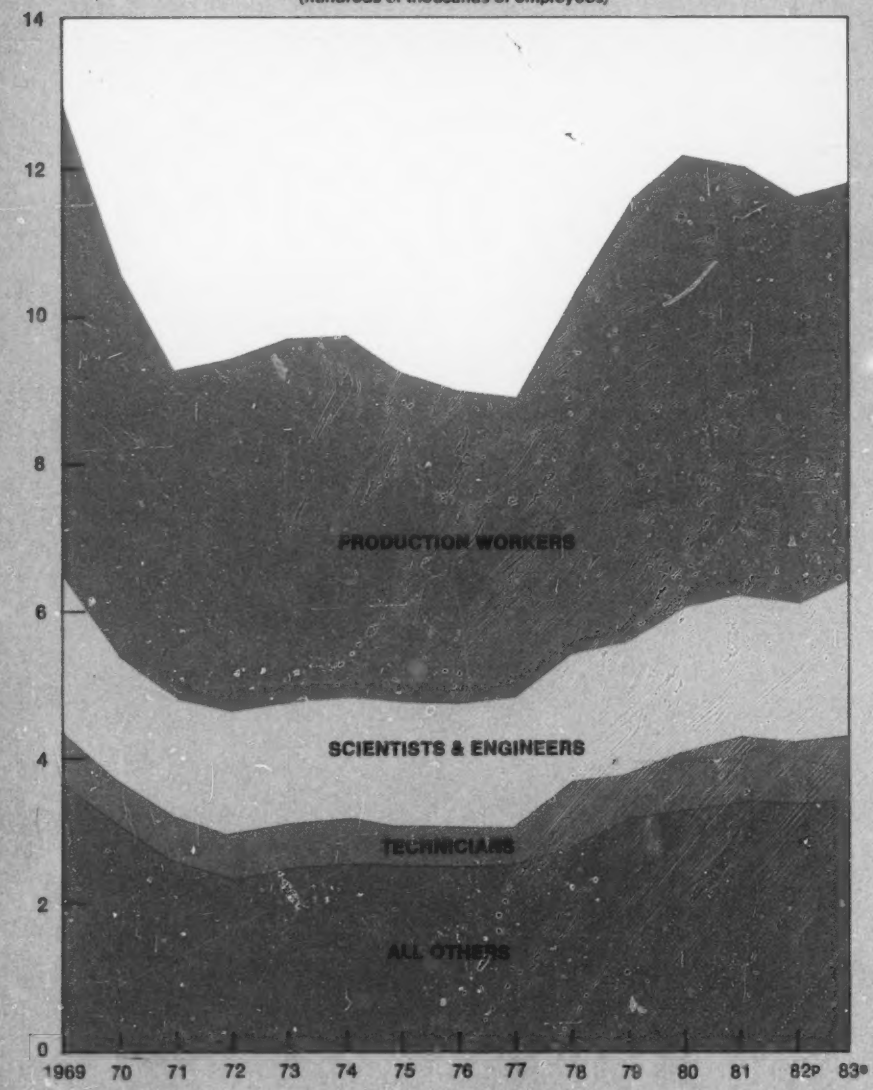
e Estimate.

Shipments of civil aircraft plunged in both numbers and dollar value in 1982. The industry delivered 5,020 aircraft, less than half the 1981 level and only 28 percent of the peak year total shipments (1978). Dollar value declined from $13.2 billion in 1981 to $8.6 billion in 1982. (The latter figure is the value of complete airplanes delivered during the year; it differs from the earlier mentioned sales figure of $11.2 billion, which includes spare engines and parts, in addition to the value of aircraft deliveries.)

Commercial transport deliveries accounted for more than 73 percent of the total dollar value. The industry delivered 233 transports (down from 387 in 1981) worth $6.4 billion (down from $9.7 billion). General aviation shipments fell to 4,150 (down from 9,457) valued at $1.9 billion (down from $2.9 billion). Helicopter deliveries declined to 637 units, down from 1,072; dollar value dropped to $398 million, down from $597 million. Projections for 1983 show a moderate rebound, to total shipments of 5,509 aircraft valued at $9.4 billion.

AEROSPACE EMPLOYMENT

(hundreds of thousands of employees)



Source: Aerospace Industries Association, based on data from the U.S. Department of Labor and AIA estimates.

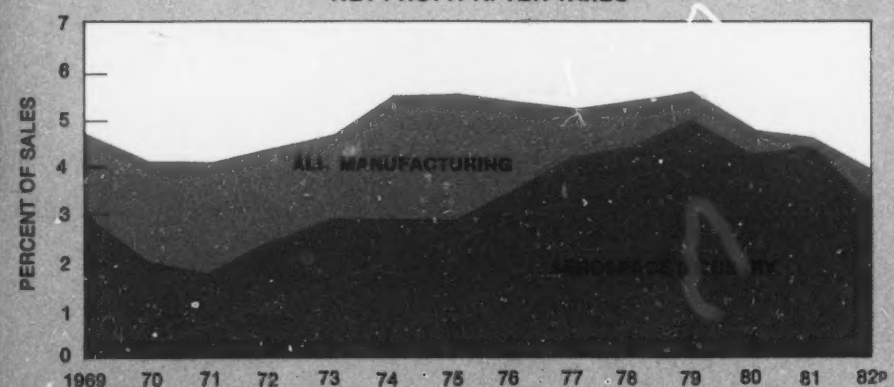
p Preliminary

e Estimate

At year-end 1982, the aerospace industry labor force numbered 1,162,000, down from 1,203,000 at the end of the previous year. Most of the drop was in production workers (down 33,000 to 545,000), due largely to reduced levels of civil aircraft production. The number of scientists/engineers remained the same as in the previous year, while there were slight declines among technicians and in the "all others" category. A moderate employment gain—to 1,185,000—is forecast for 1983.

Despite the personnel decline, the annual aerospace payroll reached an all-time high of $33.2 billion and estimates for 1983 indicate a further increase to $35.5 billion.

NET PROFIT AFTER TAXES



Source: Aerospace Industries Association, based on data from the Federal Trade Commission and AIA estimates.

p Preliminary.

The aerospace industry recorded a profit after taxes of $2.3 billion in 1982, down from $3 billion in 1981. Measured as a percentage of sales, the profit rate was 3.3 percent; that compares with 4.4 percent for 1981 and an average of 4.5 percent for the five year period 1977-81. The 1982 figure compares with 4.0 percent for all U.S. manufacturing corporations.

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RESOLUTION

WHEREAS: The U.S. Savings Bonds program is important to our national interests and has proven to be beneficial to all citizens of our country; and

WHEREAS: Through a healthy U.S. Savings Bond program, our federal debt management will be improved, inflationary pressures reduced and our overall economy benefited; and

WHEREAS: Owners of U.S. Savings Bonds are now guaranteed a competitive, equitable return on their savings regardless of market conditions; and

WHEREAS: The Aerospace Industries Association member companies have supported the U.S. Savings Bonds Program by making bond purchases available through payroll savings plans; and

WHEREAS: Employees of member companies have supported and shown leadership in U.S. Savings Bonds campaigns, thus rising to the needs of our country in past campaigns;

NOW THEREFORE BE IT RESOLVED: That the Aerospace Industries Association endorses the U.S. Savings Bonds Program and encourages its member companies to conduct aggressive campaigns to promote the participation of all employees in the purchase of U.S. Savings Bonds.

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OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION • SPRING 1983

YOUR DEFENSE BUDGET

By CASPAR W. WEINBERGER
Secretary of Defense

Notable views of notable people on aerospace matters...

aerospace perspectives

From the report of the President's Commission on Strategic Forces:
"In order for deterrence to be effective, we must not merely have weapons, we must be *perceived* to be able and prepared—if necessary—to use them effectively against the key elements of Soviet power. Deterrence is not an abstract notion amenable to simple quantification. Still less is it a mirror image of what would deter ourselves. Deterrence is a set of beliefs in the minds of the Soviet leaders, given their own values and attitudes, about our capabilities and our will."

Senator John Tower, *Texas, Chairman of the Senate Armed Services Committee, writing in the Los Angeles Times:*
"We may well be at a decisive fork in the road. One path represents the familiar trail of the democracies: a narrow, inward focus on domestic economic problems and the building of a welfare state, a lack of appreciation of our interests in the course of world events, and political expediency within our leadership.

"The second path is one of commitment, prudence and resolve—breaking the pattern of hesitation and inconsistency that has plagued our national security policy since the Vietnam era.

"This Administration has a realistic view of the world as it is, not as we wish it were. The President has chosen the prudent course of action. If we fail to follow that course, the military balance will not be restored before the turn of the century. I think the consequences of that predicament should weigh heavily on further Congressional review of the Reagan defense program."

Alun Chalfont, *British writer, in an article "The Great Unilateralist Illusion" in Encounter, a monthly journal of opinion published in the United Kingdom:*
"Those unilateralists who—unlike most of their leaders—recognize the real dangers of Communist Imperialism usually fall back on another argument, namely that if the United Kingdom were to abandon its nuclear weapons, 'others' would follow suit, and the way would be open for an end to 'confrontation' and the establishment of a world of stable and peaceful 'coexistence.'

"This must surely qualify as the definitive triumph of wishful thinking, of hope over experience.

"The Soviet Union is governed by men of cold realism; one of them, Mr. Yuri Andropov, who might be presumed to know what he is talking about, has recently described the idea of unilateral disarmament as 'naive.' The French have never shown much disposition to follow Anglo-Saxon examples, and it is significant that the reaction of their government to the uproar of the 'peace movements' is to improve the effectiveness of their national nuclear deterrent.

"Anyone who believes that the Chinese would pay the slightest attention to some unilateral gesture in the United Kingdom is clearly living in a world of fantasy; and the idea that Israel, South Africa, India, Pakistan or Argentina, or for that matter Libya or Iraq, might change their nuclear policies in response to a moral initiative from London is too ludicrous even to contemplate. An elementary process of elimination leads to the conclusion that there is simply no one left to follow our example."

T. J. Murrin, *President, Energy and Advanced Technology Group, Westinghouse Electric Corporation, in remarks to the National Security Industrial Association on his acceptance of the Forrestal Memorial Award in Washington, D.C.:*
"Today our country is involved in two worldwide competitions, analogous perhaps to two simultaneous super Super Bowls. One is the military and political competition our nation faces with the Soviet Union. The other is the intense industrial and commercial competition we face in the international marketplace . . . I am still confident that we can win both of these Super Bowl competitions, because we in the United States have the technology, we have the people, and we have the other resources to meet such military and economic challenges. But our response will probably be insufficient if things continue on their present course, because doing it the same way we've earlier done it will no longer be sufficient. We must choose some different approaches . . .

"We need to choose goals that will unleash the creative American genius that has too long been buried in bureaucracy and too long stifled by micromanagement. We need to choose trust over unnecessary burdensome restrictions. We need to choose a rebirth of the American entrepreneurial spirit over a continuum of the frustration plaguing our nation.

"We need to choose new approaches and new technologies that will allow us to protect our leadership where it still exists, and to recapture it where we have lost it.

"We need to choose consensus leadership over adversarial relationships. We need to choose action over rhetoric. And we need to take action such that our factories, our products and our management are second to none. We are free to make all of these choices."

James M. Beggs, *Administrator, National Aeronautics and Space Administration, addressing a group of White House Fellows in Washington, D.C.:*
"The industrial nations of the world are moving ahead of us in science and engineering education. For example, in 1980 we graduated 69,000 engineers. The Japanese, with half our population, graduated 80,000—more than double the number per capita for every one of ours. And the Soviet Union graduated 320,000. And, incidentally, if you worry about the Japanese, consider this: we graduate seven times more accountants than they do and 21 times more lawyers."

AIA
aerospace

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The purpose of AEROSPACE is to

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems.

Foster understanding of the aerospace industry's responsibilities in the space exploration program.

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade.

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

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25 Years in Space

By KARL G. HARR, JR.
President, Aerospace Industries Association

This year marks the 25th anniversary of the National Aeronautics and Space Administration and its civil space program. You have a choice of anniversary dates: July 29, when—in 1958—President Eisenhower signed the National Aeronautics and Space Act; October 1 of that year, when NASA officially opened its doors for business; or October 11, when NASA launched its first spacecraft.

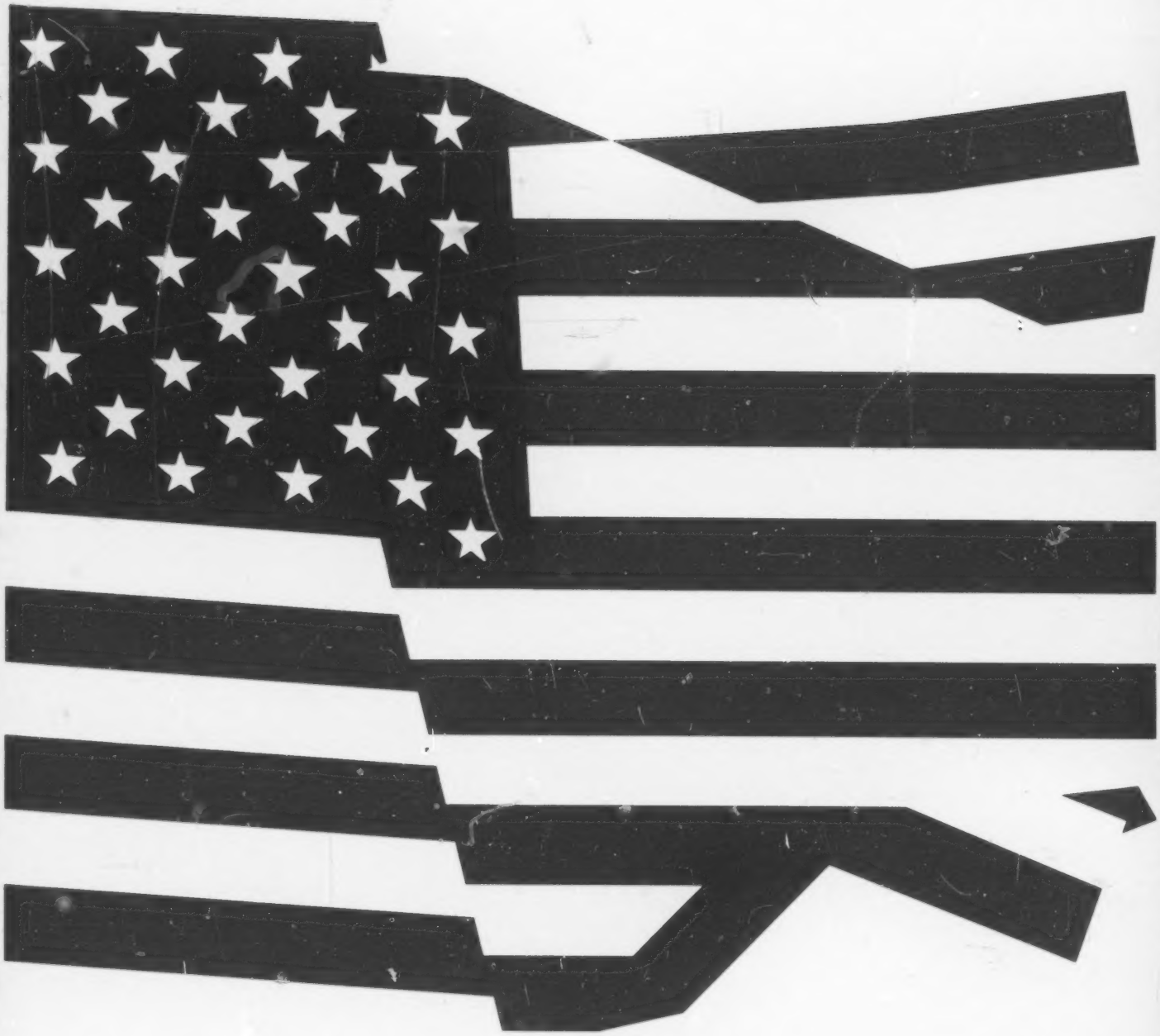
That first spacecraft was Pioneer 1, which was designed to make a close pass at the moon and report lunar data—but it went less than one-fourth of the distance. Nonetheless, it was widely acclaimed because the 70,000-mile altitude it attained was a record, the greatest distance from Earth any man-made object had ever reached. That's the kind of year it was; there were 17 launches in 1958 and 10 of them were failures, but the failures became "partial successes" in the public view. Our image as world technological leader had been badly bruised by the Soviet *sputniki* and we grasped at any indicator, like Pioneer's record, that suggested we were "catching up" with the Soviets.

The civil space program has come a long way since that bleak year 1958. NASA has produced a series of scientific and technological triumphs that have contributed much to restoring the U.S. image. In a quarter century, NASA programs have generated more knowledge about Earth and the universe than man had acquired in all the prior years of history. NASA also blazed the trail for a number of direct benefit space systems, such as the weather, communications and Earth resources survey satellites now in operational service. Perhaps most important is the expanded national technology base that NASA has created in carrying out its programs, a bank of knowledge that—to quote NASA Administrator James M. Beggs—"creates new industries, new jobs, spurs innovation and strengthens the national economy."

Remember, too, that this year also marks the 25th anniversary of the military space program. It was the Army that launched the first U.S. satellite on January 31, 1958. Six weeks later, the Navy sent up the first Vanguard. And in December of 1958, the Air Force and the Advanced Research Projects Agency teamed on Project Score, the first experiment—by any nation—in space communications. The Department of Defense has also come a long way in space. It has built a broad space capability in three categories: satellites that support land, sea and air operations; satellites that gather intelligence; and ground-based systems for keeping track of all objects in orbit—ours and theirs.

The success of the civil and military space programs represents a lot of work by a lot of dedicated people in NASA, in DoD, and in the aerospace industry, supplier of space equipment to both agencies. To all these people, Aerospace Industries Association extends congratulations for a quarter century of solid achievement and a sincere "Well done."

YOUR



DEFENSE BUDGET

By CASPAR W. WEINBERGER
Secretary of Defense

Military Expenditures: Investment

Total Soviet investment in military capabilities is approximately double that of the United States. Investment includes procurement, construction, and research and development. The total for the U.S.S.R. is an estimate of what it would cost the U.S. to duplicate the Soviet investment.

This article is an excerpted version of the Department of Defense publication *"Your Defense Budget: Fiscal Year 1984."*

For twenty years the Soviet Union has been steadily accumulating enormous military might, most of which is designed for offensive actions. For much of that period the United States restrained its own military spending; in fact, investment in our defense actually declined in real terms during most of the 1970s. The result was a dangerous shift in the military balance, which threatens our ability to deter and, if deterrence fails, to defeat aggression.

In effect the Reagan Administration has had to accept "double duty." First, we have had to act quickly to improve the basic readiness and staying power of our forces, so that if an immediate crisis were to arise, we would be ready to meet it. Being ready to meet such a crisis is the best way to avoid or deter it.

But at the same time as we are ensuring that the forces we have are ready, we are making up for lost years of investment by emphasizing research and development and by modernizing and strengthening all our forces, particularly all three parts of our strategic triad of deterrence, to meet future threats.

There is simply no way to shirk this double duty, unless we are willing either to forfeit basic readiness of the forces we have, or to pass on to future generations a legacy of neglect that adds to, and indeed helps to create, the dangers we face. We believe that the American people want us to do neither. But the American people also want to know just why and how their tax dollars are being spent.

Three broad and important questions are often raised about the defense budget:

- Why must we spend so much on defense?
- What is our long-term defense program and how does the Fiscal Year 1984 budget fit in?
- How does defense spending affect our economy?

WHY MUST WE SPEND SO MUCH?

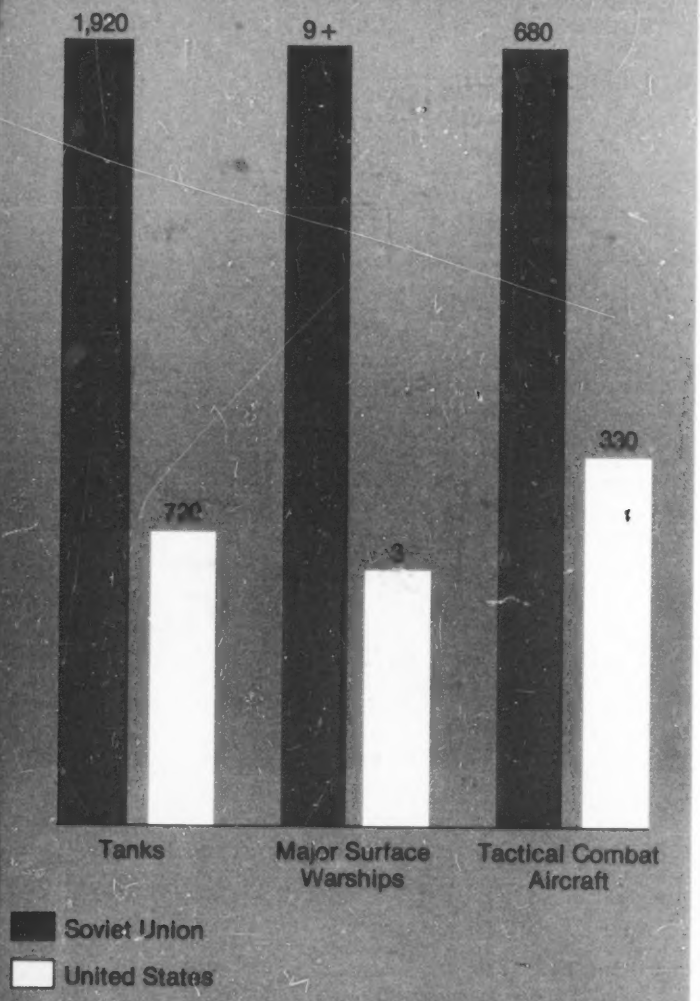
The national security policy of the United States is peaceful and defensive. We do not intend to attack any nation or to start any war. Rather, we seek to *deter* attacks on ourselves and our allies. Thus, in planning our defenses we must begin by looking at the military threats confronting us. Then we develop our strategy and design our forces in light of them.

Far and away, the most important threat to our national security is from the Soviet Union, the only nation that could inflict large-scale, direct destruction on our territory and our people. Put simply, this threat looms large because for the past 20 years the Soviets have been investing huge sums in their military establishment, because they have been producing massive nuclear and conventional military forces, and because they have been extending the reach of their military power in a variety of ways.

Soviet military spending. About 15 percent of Soviet gross national product (GNP) goes to defense, compared with less than eight percent of our own larger GNP. Total Soviet investment in future military capabilities—that is, production of weapons and other equipment, construction of military facilities, and research and development—is nearly double ours.

The essential picture is clear. Not only do the Soviets invest a far greater share of their nation's resources in defense than we do (at no small cost to their struggling agriculture and nondefense industries), but in absolute terms they are outspending us by a considerable margin.

A Comparison of Average Annual Soviet Production and FY 1984 U.S. Requests



In most cases, the Department of Defense request for weapons procurement in Fiscal Year 1984 represents only a fraction of the average annual Soviet production over the last nine years.

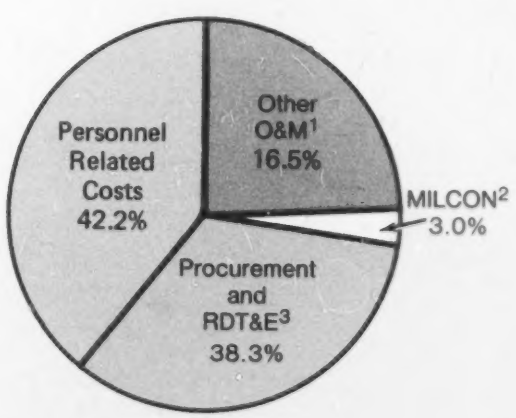
Soviet military production. More important than the "input"—what the Soviets put into or spend on defense—is the "output"—the tanks, planes, ships, missiles and other military hardware they produce and deploy. For example, between 1974 and 1982 the Soviets and their Warsaw Pact allies produced more than twice as many tanks, nine times as many artillery and rocket launchers, and more than six times as many ballistic missile submarines as the United States and its NATO allies combined.

These rates of production enable the Soviets to continue—and indeed in many instances to widen—their numerical advantages over us in most major categories of weapons. Further, over the past decade the Soviets also have made significant advances in the quality of their military hardware, thus seriously narrowing the overall technological advantage the United States has long enjoyed.

The reach of Soviet military power. Over the past decade or so, in addition to continuing their military occupation of most of Eastern Europe, the Soviets have demonstrated a dangerous willingness and ability to extend the reach of their military power through:

- security cooperation agreements in Africa, the Near East, Asia, and even in our own hemisphere;
- massive arms deliveries to Third World countries;
- a doubling over the same time period of the number of Warsaw Pact military and technical advisors on extended tours in other countries;
- the use of Cuban and East German military proxies in Africa and Central America;
- a steady buildup of Soviet power projection capabilities—i.e., their naval, naval infantry, airborne, and airlift forces;
- expanded overflight and access rights, as well as operating bases, in key parts of the world; and, most dramatically,
- the invasion of Afghanistan in 1979.

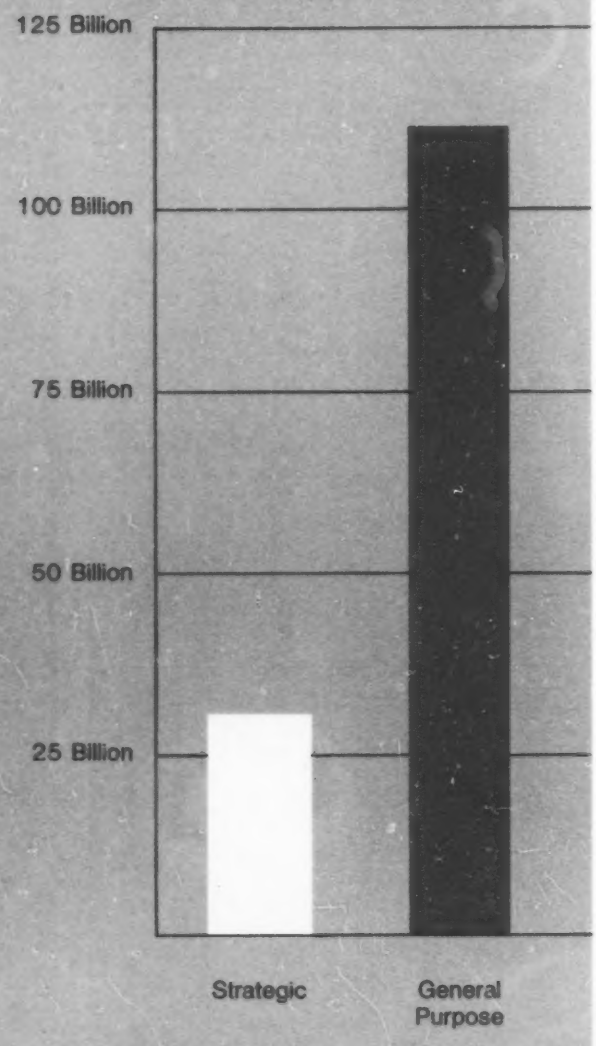
Budget By Category
FY 1984
(Outlays)



[1] Other O&M: Non-personnel Operations and Maintenance
[2] MILCON: Military Construction
[3] RDT&E: Research, Development, Test, and Evaluation

Procurement of new weapon systems and other hardware does not dominate the U.S. defense budget; the largest share goes for people.

General Purpose and Strategic Forces
FY 1984 Constant Dollars
(Total Obligational Authority)



For Fiscal Year 1984, the Department of Defense proposes to spend four times as much on general purpose, or "conventional" forces, as it will on strategic nuclear forces.

All of this adds up to growing Soviet military power which extends well into many areas of vital interest to the United States and our allies and friends. Through this massive and relentless buildup, the Soviets have:

- erased U.S. strategic nuclear superiority;
- deployed new, powerful intermediate-range nuclear missiles that so far have been unmatched by NATO;
- increased the firepower and mobility of their ground forces; and
- begun to deploy a navy with much longer reach and greater firepower.

The facts are clear on one point: the Soviets are in this for the long haul. Theirs is a steady and long-term military buildup (most of it clearly intended for *offensive* use), already into its third decade, as contrasted with the historical U.S. pattern of fluctuating defensive expenditures.

The U.S. response. In short, we must spend so much on defense because the threats we must deter are numerous and great. U.S. strategy for dealing with these threats incorporates three main principles:

- Our strategy is *defensive*, that is, we do not seek to start any war. This makes planning for our defense difficult because the potential aggressor has the advantage of being able to select the time and place of attack.
- Our strategy is to *deter* war, by convincing potential aggressors that the costs of an attack on us or our allies would be prohibitive.
- If deterrence should fail, our strategy is to *restore peace on favorable terms*, by defeating the attack while achieving our national objectives and trying to limit the scope of the conflict.

WHAT IS OUR LONG-TERM PROGRAM?

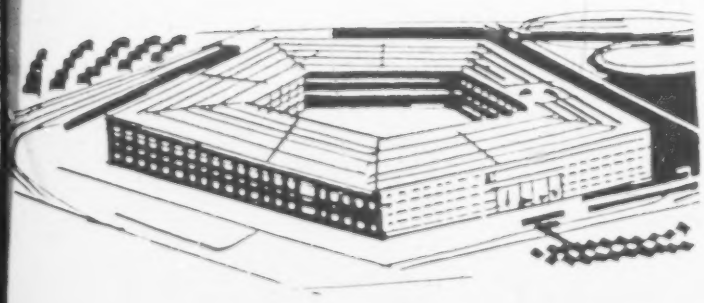
Given the Soviet and other threats we face and given our defensive strategy to deter war, we have established a long-term program to meet several imperatives for U.S. defenses—readiness, forward deployment, mobility, sustainability, modernization, and nuclear deterrence. In each of these areas, the FY 84 defense budget builds on past progress and continues the momentum towards meeting our long-term requirements.

Readiness. As a defensive power which has global interests and which faces varied threats, the United States must be ready to go to war quickly if necessary. This requires first-rate and highly trained personnel and well-maintained weapons and equipment. Improving the readiness of U.S. forces has been one of our highest priorities, and great progress is being made.

Forward deployment. We continue to strengthen our forces deployed on the homelands of our traditional allies in Europe and East Asia and to prepare for new contingencies in Southwest Asia. This is one of the ways we can "multiply" our forces and help make up for the great advantages in sheer numbers the USSR possesses.

Mobility. We must be able to move forces rapidly to distant parts of the globe to protect our interests and those of our allies. Only if we have a demonstrated capability to do so can we be confident that we can deter potential attacks. How many forces we can move from one place to another is the crucial factor. That is why we are making major investments in strategic airlift and sealift.

Sustainability. In addition to maintaining our forces in Europe and East Asia and being able to move other forces quickly to trouble spots, we must be prepared to resupply our fighting units during sustained combat. Our long-term goal is to match the "staying power" of the Soviets' forces. To this end we have proposed in the last three defense



budgets major funding increases for ammunition, spare parts, fuel, and other critical support items—the "nuts and bolts" of defense. Sustainability is a vital component of defense, but one that is not very glamorous and therefore is often overlooked. It will require steady annual increases in future funding to achieve these very important objectives.

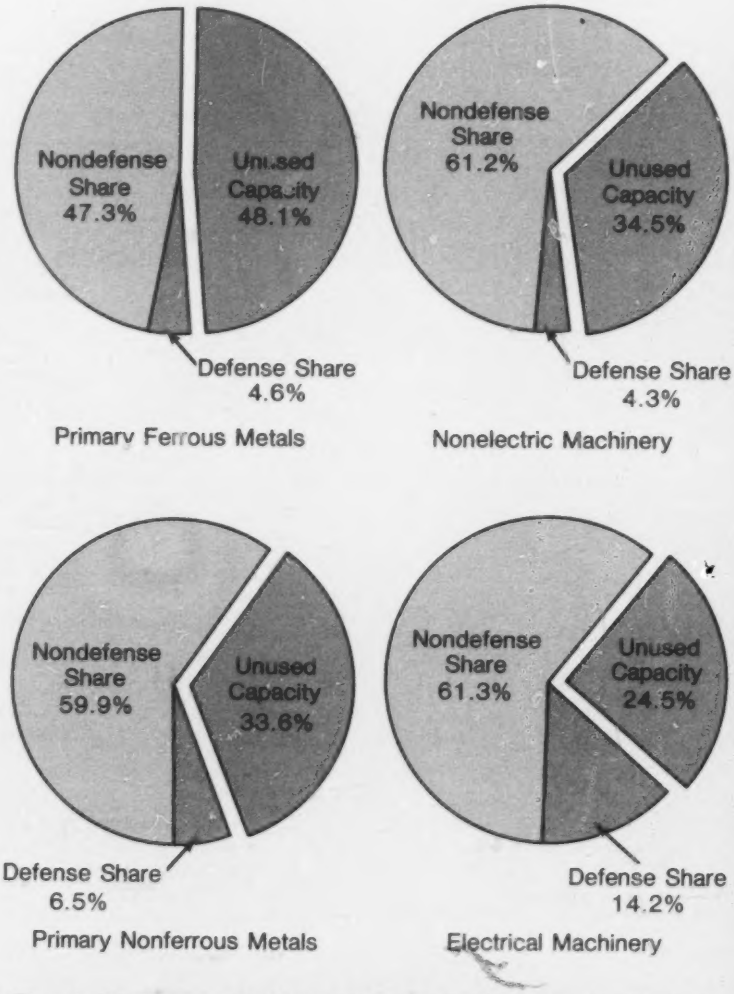
Modernization. The Soviets are continuing to field more modern and more potent weapons that pose new and greater threats to our forces. For this reason, providing our own conventional (non-nuclear) ground, sea, and air forces with modern, effective weapons has very high priority in our long-term defense program. It is ironic and a serious lesson for all of us that much of the Soviets' high technology has been developed directly from skills and knowledge either bought or stolen from us by the USSR.

We do not pursue technology for technology's sake. Instead, we develop and field more sophisticated weapons in order to counter the quantity and the quality of our adversaries' weapons. Equipping our troops with weapons at least as good as those that threaten them is expensive yet necessary.

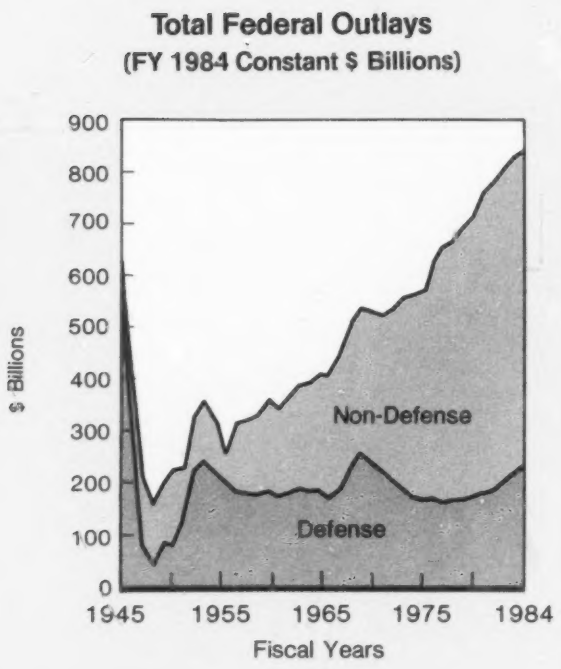
Nuclear deterrence. America's ability to keep the peace is built on a foundation of nuclear deterrence. In October 1981, President Reagan announced a five-part program to modernize our strategic nuclear forces. The FY 84 budget provides funds to advance each of these major programs:

- the B-1B strategic bomber, designed to bridge the gap between the aging B-52 and the "Stealth" bomber of the 1990s, and then to remain in service as a cruise-missile carrier well into the 1990s;
- the M-X Peacekeeper intercontinental ballistic missile which will eventually give us a survivable, land-based missile that is the equal of the best the Soviets have;
- the Trident II or D-5 submarine-launched ballistic missile, which will have highly accurate warheads and will be loaded in the late 1980s aboard Trident submarines whose ability to patrol the oceans undetected by the Soviets will be unquestioned into the 1990s;
- augmented air defenses for the North American continent to provide warning and intercept capability to meet any potential Soviet bomber threat; and

Share of Total Industry Capacity Used in Defense and Nondefense Production in 1982



There is virtually no way that defense spending can "crowd out" non-defense production, because the U.S. is operating at only two-thirds of its full industrial capacity—a 34-year low. As the chart shows, the percentage of total capacity devoted to defense production is well below the percentage of unused capacity in four major industries—thus considerable room remains for expanded civil production.



Non-defense spending has skyrocketed over the past 15 years, while defense spending slipped and is only now approaching its 1968 level in inflation-adjusted terms.

- survivable, enduring, strategic communications, command and control so that the President and the other national command authorities can maintain contact with and issue orders to all of our strategic nuclear forces even after a Soviet first strike.

Also this year we will begin the deployment of the intermediate-range nuclear forces agreed to by our NATO allies in December 1979—464 ground launched cruise missiles and 108 Pershing II ballistic missiles. These potent weapons will fill an existing gap in the continuum of NATO deterrent forces from conventional ground, sea, and air units up to the strategic nuclear forces of the United States.

Overall, ours is a balanced program, one that meets the special requirements of our strategy of deterrence.

HOW DOES DEFENSE SPENDING AFFECT OUR NATION'S ECONOMY?

We do not have to choose between a strong defense and a strong economy. Our experience has shown that the two are compatible.

During the 1950s, defense spending averaged 10.1 percent of GNP; during the late 1960s, 8.6 percent; during the 1970s, 6.0 percent. The FY 84 defense budget represents 6.8 percent of GNP. Real economic growth was higher during the 1960s (averaging 4.2 percent a year) than during the 1970s (3.3 percent a year), even though the share of GNP allocated to defense dropped considerably from the 1960s to the 1970s.

Three principal concerns dominate discussions about the effect of defense spending on the economy: the capacity of U.S. industry to accommodate expanded defense production; the effect of increased defense spending on inflation; and the effect of increased defense spending on the budget deficit.

Industrial capacity. In a time of recession there is virtually no way that defense spending can "crowd out" nondefense production. The United States is presently operating at two-thirds of its full industrial capacity—a 34-year low. In heavy industries, where much defense production is concentrated, the situation is even worse. As the economy recovers, however, this unused capacity will be utilized again. But the percentage of total capacity devoted to defense production in four major industrial categories is far smaller than the percentage of unused capacity. Thus, even with our full defense program underway, considerable room for expanded production remains available.

Inflation. Another persistent question is whether increased defense spending fuels inflation. Recent history indicates the answer is no. In light of the considerable unused industrial capacity in our nation today, it is highly unlikely that even major increases in defense spending would force inflation to go up. And in the past two years when real defense spending increased about six percent per year, the inflation rate fell from 9.3 percent in 1980 to six percent in 1982, and indeed in the last quarter of 1982 was only about four percent.

Budget deficits. Cutting back on defense is not the solution to our nation's deficit problem. Because each year's budget authority is actually spent over several years, even a large cut in this year's defense budget would not significantly reduce the current deficit and could endanger American security.

Obviously federal spending levels affect the size of the budget deficits. It is true that both total federal spending and federal deficits have grown significantly over the past two decades. But nondefense spending sky-rocketed over the past 15 years, while defense spending slipped and is only now approaching its 1968 level, if the effect of inflation is disregarded.

Long-term efficiency in defense. There are significant long-term economic benefits to be gained by maintaining our current defense plans—and substantial long-term costs in cutting them back. In response to our current proposals, defense industries have begun to make long-term plans to rebuild our defense. New plants are being built, assembly lines opened, equipment purchased, workers hired, and new people trained. Sudden cutbacks now would mean shutting down assembly lines and laying off workers—shifting into reverse just as we were getting out of first gear. Not only would there be costs involved in cutting back now, there would be additional costs if we decided at a later time to start up again. That is too high a price to pay for small, short-term savings.

We have undertaken a concerted effort to improve efficiency and to eliminate waste, fraud, and mismanagement in the Defense Department. We have concentrated on three areas: planning, acquisition improvements, and management oversight.

We are steadily advancing against inefficiency on a broad front. New reforms are constantly sought in order to reduce costs further. Much has been accomplished and more will be achieved to ensure that our defense rebuilding is both economical and efficient.

The key to ensuring long-term efficiency and, more importantly, to preserving our national security is a steady and sustained defensive buildup. We have paid a price—in terms of both our security and our economy—for the fits and starts of the past. The threats are real and continuing. We have begun a long-term program to rearm America, and in FY 84 we must continue on that path.

If we do this, we can have high hopes that our renewed strength will deter attacks upon us. If we do not, we will be trusting our future and our country's heritage to dangerous guesswork and wishful thinking.

THE MOON AND ANTARCTICA

The author, left, with the late space pioneer Dr. Wernher von Braun.

By HANS MARK
Deputy Administrator
National Aeronautics and Space Administration

About 10 years ago, I was invited to go on the annual Farallon Island sailing race by a friend of mine with whom I did much sail boat racing in San Francisco Bay during those years. As it happened, Wernher von Braun was in town and, as he was a great sailing enthusiast himself, we asked him to come along.

The Farallon Islands lie about 20 miles directly west of the Golden Gate and we had strong westerly winds on that day. Going out of the Golden Gate and sailing around the Islands turned out to be hard work since we had to tack continuously to make certain that none of the other boats in the race gained an advantage over us. We rounded the Islands shortly after lunch, and with the wind at a comfortable angle on our quarter, we had a very fine sail back to San Francisco. We were very relaxed and happy and Wernher took this opportunity to start talking about his ideas on the future of space exploration.

At the time, you remember, we were just finishing the Apollo flights and someone in the crew asked Wernher when we would ever go back to the moon. For the next three hours, we were treated to an absolutely enthralling lecture on why we will go back to the moon and just how it will happen. What Wernher did was to draw an analogy between our exploration of Antarctica and our coming exploration of the moon. I would like to reconstruct the story that Wernher told, as best as I can remember it, because I think the insights he had on this matter will turn out to be accurate.

Wernher started his lecture by pointing out that the speculation about the existence of a large Antarctic Continent and the possibility of going to the moon began at about the same time during the early Renaissance period in Europe. He cited, as an example, the legend of Cyrano de Bergerac (later turned into the famous play by Edmond Rostand) as the first real speculation about people going to the moon.

At the same time, the early navigators speculated on the existence of a vast southern continent—Terra Incognita Australis—that covered the southern part of the Earth. Some actually skirted the edges of the as yet undiscovered continent of Antarctica. Inevitably, the flower-

In 1928, Admiral Richard E. Byrd used this Fokker Universal to overfly large portions of the Antarctic continent that had not been explored. The airplane was thus the "enabling technology" that opened up a new era of Antarctic exploration.

Antarctica now has a permanent population of more than 1,000 and a summer population sometimes approaching 10,000. Ski-equipped aircraft, such as this Lockheed C-130, deliver supplies to the research communities.

ing of the imagination that characterized the Renaissance led to concrete steps.

Captain James Cook of the British Royal Navy was actually the first to cross the Antarctic Circle in 1774. While a number of expeditions were mounted to the Southern Ocean, what turned out to be the mainland of the continent was not sighted until 1820 by Commander Edward Bransfield of the Royal Navy. A year later, the American sealer, Captain John Davis, was the first to actually set foot on the continent itself, early in 1821.

Antarctica was like the moon, Wernher said—it was terribly difficult to reach and thus it was not done very often. Furthermore, since people could not live on supplies that existed in Antarctica, a complex logistics chain had to be built. For two or three abortive seasons in the early years of the 19th century, there was some seal hunting on the northern reaches of the Palmer Peninsula—which is actually north of the Antarctic Circle—but these efforts were soon abandoned. The great scientific and industrial revolutions, together with the growth of nationalism in the 19th century, led to a revival of interest in the exploration of both the Arctic and the Antarctic continents. It became a matter of national prestige to mount expeditions to the Earth's polar regions.

There is no doubt that the most dramatic (and also tragic) event in this "race to the Pole" was the 1911 competition to reach the South Pole between Roald Amundsen of Norway and Captain Robert Falcon Scott of the British Royal Navy. Scott had been to Antarctica before, so for him this effort was a genuine fulfillment of a stated ambition. For Amundsen, on the other hand, the South Pole was a target of opportunity. He had actually shifted his objective from the North Pole to the South Pole when the American Admiral Robert E. Peary succeeded in reaching the North Pole before Amundsen in 1909.

The outcome of the Scott-Amundsen race is well known: Amundsen reached the South Pole on December 14, 1911, and left a message as well as a Norwegian flag on the spot. These were found four weeks later when Scott and four companions also managed to reach the Pole—on January 17, 1912—after a very difficult and grueling journey. Scott and his friends never made it back to their base camp, perishing within 10 miles of their goal.

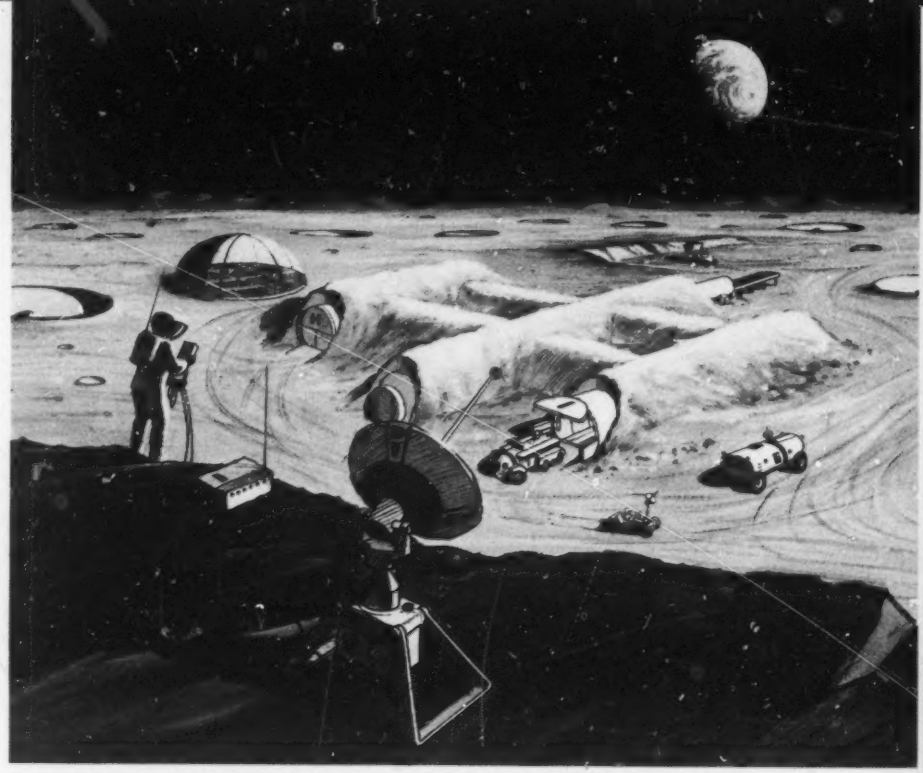
It is perhaps an interesting sidelight that Amundsen won the race because he adopted the technology that the Eski-

mos had worked out for long distance travel in the Arctic—the dog sled. Amundsen used a dog sled and started his trip with a team of 52 dogs. He returned with only 12, so that you can see that what the Eskimos had taught him was to use what was essentially a staged launch vehicle. The cargo sleds were discarded as the supplies were consumed, and as fewer sleds were required, the weaker dogs were killed to provide food for the stronger ones.

Scott did not use Eskimo technology. He decided to use mechanical equipment and actually was the first to bring motor tractors to the southern continent. As a backup, in case the tractors failed, he brought along Shetland ponies. Well, both the tractors and the ponies proved unequal to the rigors of the Antarctic climate and Scott and his companions actually wound up dragging their own sleds from what is now McMurdo Sound to the South Pole. It is a tribute to their great courage and fortitude that they achieved as much as they did.

Wernher von Braun made the point during his lecture that the Apollo program was motivated by much the same factors that motivated the maritime nations in the early years of this century to fund expeditions for the race to the South Pole. First and foremost was national prestige, but that was not all. There was clearly also an overtone of potential military applications. With Britain especially, the polar explorations were closely related to naval supremacy. So it was also with the race to the moon between ourselves and the Russians. Here as well, national prestige was the primary motivation but there was also an offstage implication of military applications, since the technology to get to the moon was clearly related to modern military technology. Of course, we won the race to the moon with the triumphant landing of Apollo 11 on the lunar surface on July 20, 1969. The Russians abandoned their efforts in the same year after several costly launch vehicle failures.

Possibly the analogy that Wernher drew for us might be somewhat tenuous, but it might be profitable to pursue it anyway, to see if we can learn anything from what happened in Antarctica after the epic journeys of Amundsen and Scott in 1911. The most interesting fact is that, for about two decades, not much of any consequence happened in Antarctica. Once the requirements of national prestige were fulfilled, there was no real incentive to go back. Even the imperatives of scientific research were not enough to justify the very substantial costs that trips to the Antarctic entailed in those days. Therefore, only a few small expeditions were mounted in the years following 1911.



A lunar base, such as the one shown in the artist's concept above, could be in operation by the year 2000, given an essential prior step: the enabling technology, a manned space station in Earth orbit (right).

What finally happened was that in the late 1920s a new technology appeared that opened a completely new era of Antarctic exploration. This technology was, of course, that of the airplane. By that time—the late 1920s—aircraft had become reliable enough to be used for long flights over hostile territory. Accordingly, in 1928 Admiral Richard E. Byrd became the first to overfly large portions of the hitherto unexplored Antarctic continent. In the next year—on November 29, 1929—Byrd made his first flight over the South Pole. In 1935, another American, Lincoln Ellsworth, was the first to fly completely across the Antarctic continent from the Louis Philippe Peninsula to the Bay of Whales. The airplane made it possible to explore and to map large regions of the Antarctic continent. Ski-equipped aircraft could take off from the ice fields of Antarctica with relative ease. Once the techniques of operating aircraft in cold weather were mastered, large regions of the Antarctic continent became accessible.

In essence, the airplane became the "enabling technology" that opened up a new era of operations in the Antarctic. With the airplane it was possible not only to map the Antarctic continent but also to resupply bases with air-dropped equipment and supplies and to rescue people, if that was required. There is no question that Antarctic exploration, since Operation High Jump in 1947, has been almost completely dependent on the use of aircraft.

Are there any conclusions that we can draw from this story with respect to the future exploration of the moon? I think that there are. Antarctica and the moon have three things in common: they are both hard to reach, they both require artificial life support systems to sustain human presence and, finally, both require staging bases and complex logistics operations for the maintenance of expeditions on the continent.

What is the enabling technology that is equivalent to the airplane in the case of lunar exploration? Clearly, it would be some kind of a space vehicle that could overfly the lunar surface, land wherever its crew decided to do so, and then return to wherever it came from. There is not much doubt that the vehicle we are talking about would be very similar to the "orbital transfer vehicles" that we are now discussing in connection with the development of Earth orbiting space stations. In fact, a strong case can be made that the next step in the intensive exploration of the moon cannot really be taken until we create the enabling technology that makes this step possible. This technology is the creation of an Earth-orbiting space base and the orbital transfer vehicles that go with it.

These orbital transfer vehicles and the new lunar landing vehicles associated with them would be true spaceships. They would not be "hybrids" like the Shuttle that is designed to fly both in space and in the Earth's atmosphere. The ability of a spacecraft to fly in or to pass through the Earth's atmosphere places severe design constraints on the vehicle that

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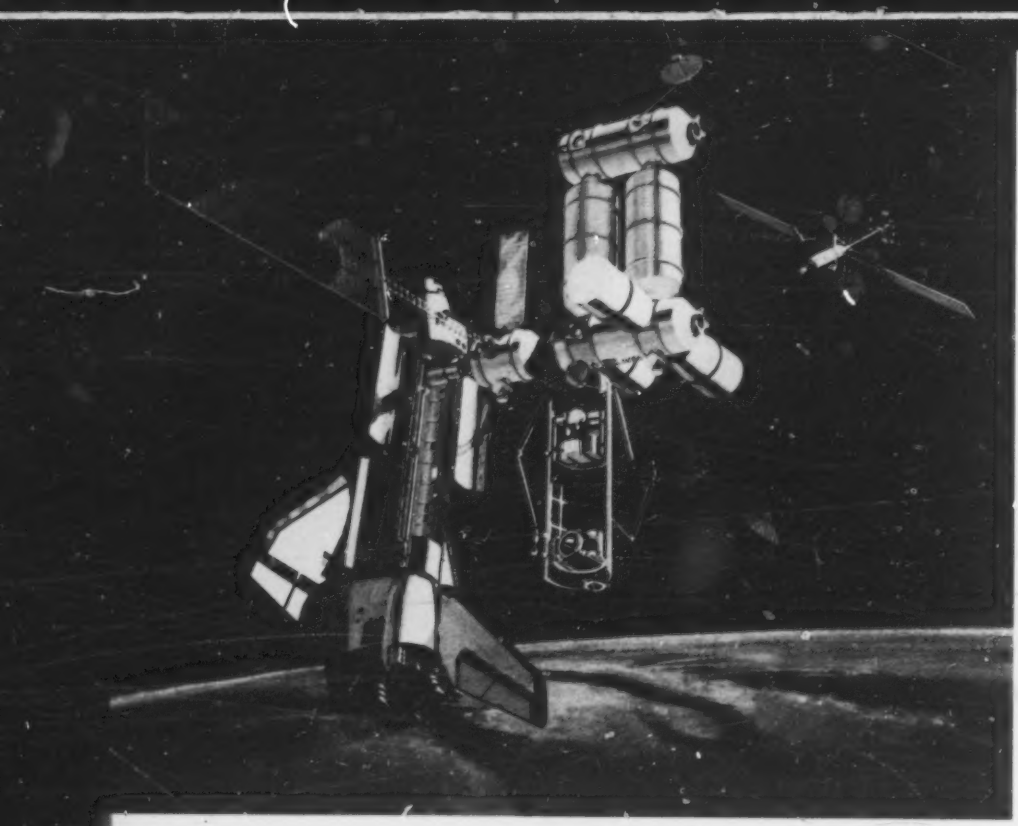


severely restrict its ability to perform as a true spacecraft. The heat shields and the necessity to make the vehicle compatible with the laws of aerodynamics add weight that is not useful for vehicles designed to fly only in space. Thus, the Earth orbiting space station is the transportation node, if you will, where the transfer will be made from Shuttle vehicles, designed to fly both in space and in the atmosphere, that will bring people and payloads from Earth to the station and back. Once at the station, people will transfer to the true spacecraft and will conduct whatever operations are feasible. Without the enabling technology of a space station and of the orbital transfer vehicle—the true spacecraft—further exploration of the moon would be prohibitively expensive.

Let me return briefly to the history of what has happened in Antarctica, to see what may happen on the moon in the coming years. There is no doubt that the airplane has been the key to Antarctic operations. A decade after 1947's Operation High Jump, a new and much more intensive series of Antarctic operations was initiated as a result of the International Geophysical Year in 1957. It was this operation, a quarter of a century ago, that led to the permanent occupation of the Antarctic continent for scientific research purposes. During this period, the first large permanent bases on the continent were established so that today a dozen nations have permanent establishments on the Antarctic continent. Today, the permanent population of the continent is in excess of 1,000 people and, during the summer in Antarctica, the population sometimes approaches 10,000. There is no doubt whatsoever that ski-equipped aircraft made these relatively massive operations on the Southern Continent possible.

What motivated the operations in Antarctica subsequent to the development of air transportation on the continent? Very probably Operation High Jump was the result of exuberance from our victory in World War II. Some good scientific work was done, but the most important result of High Jump was the establishment of the permanent American base at McMurdo Sound.

In the case of the International Geophysical Year operations, the primary motivation was scientific research. An enormous amount of information was collected and, for the first time, some ideas about the natural resources that lay buried under the Antarctic ice cap were formulated.

In the two and a half decades since the International Geophysical Year in 1957, people have turned their thoughts more and more toward the possible exploitation of the resources in the Antarctic that were uncovered by the earlier scientific expeditions. Thus, these are the events that have characterized Antarctic explorations a long period of reconnaissance for various reasons, a dash to the South Pole in 1911 executed primarily for reasons of national prestige, the application of an enabling technology to greatly widen the scope of exploration and, finally, an intense period of extensive scientific exploration leading to the practical application of whatever it is that has been discovered.

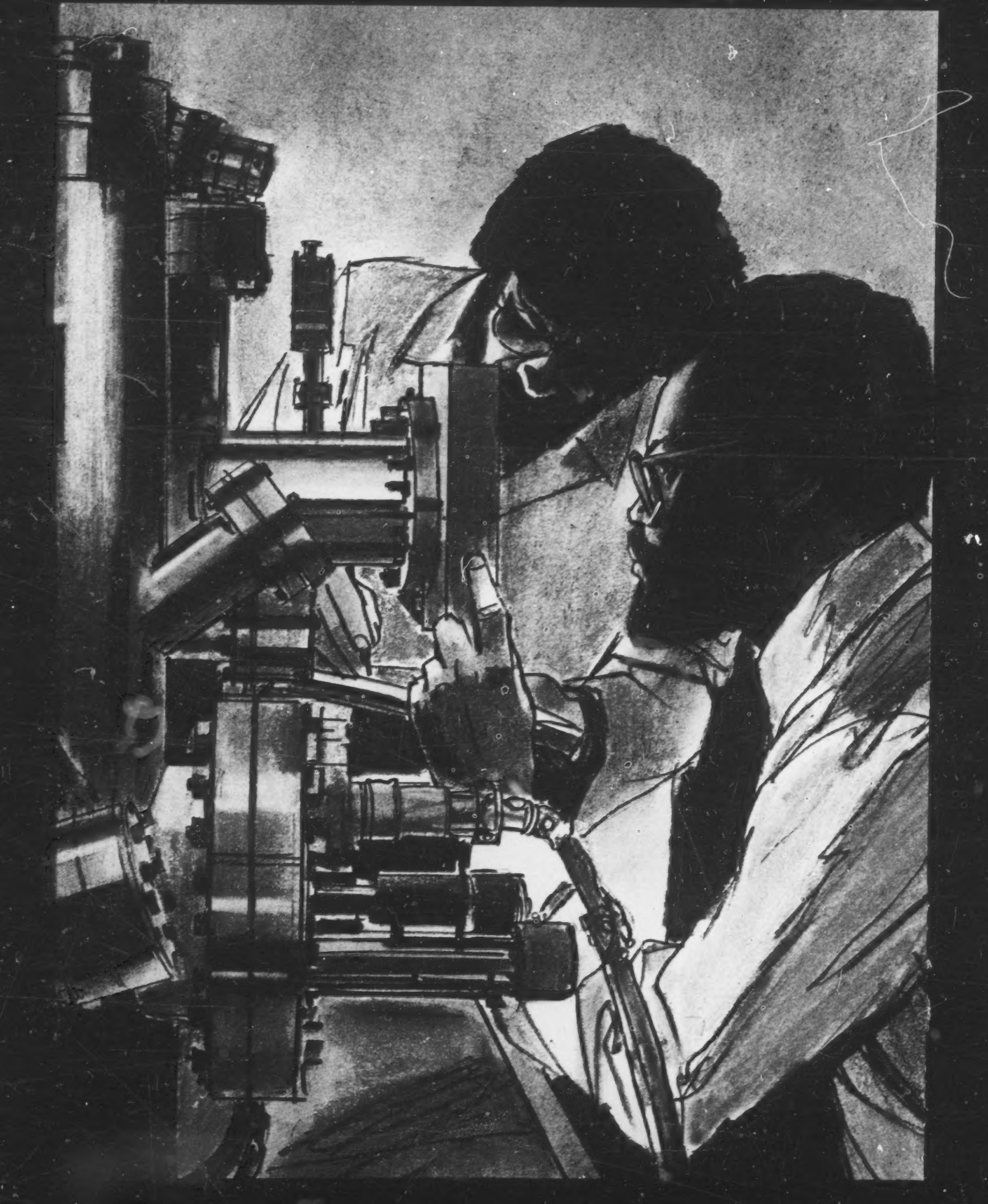
Can a case be made that we will see this history repeat itself in our future exploration of the moon? I think that such a case can indeed be developed and that Wernher von Braun's analogy will turn out to be valid in the end.

If this is the way things will happen, then what can we expect? It took approximately thirty years from the race to the pole in 1911 to the establishment of a permanent human presence on the Antarctic continent; 1942 was the last year that no one wintered on the continent. If this time scale is valid for the moon, then by the year 2000—30 years after the landing of Apollo 11—we will have established a permanent presence on the moon.

Furthermore, the permanent presence in Antarctica was established about 10 years after aircraft—the enabling technology—came into common use on the continent. Another way of saying this is that we will establish a permanent presence on the moon 10 years after we deploy the space station and its ancillary orbiting transfer vehicles, the enabling technology in the case of the moon. Since there is a reasonable chance that we will have a space station by 1990, this calculation leads to the conclusion that we will have the first small lunar base by the year 2000.

The sequence of events on the moon will probably be motivated by the same considerations that governed activities in Antarctica. The first lunar station will lead to an intensive scientific exploration of the moon, perhaps even under international auspices, as was the case during the International Geophysical Year in Antarctica. Once this phase is finished, I believe that we will turn our attention to the exploitation of lunar resources—which is what we are now preparing to do in Antarctica, more than 70 years after the dash to the pole. Again, if this time scale holds, then we should have a permanent population of the order of a thousand people on the moon by the year 2040 and we should be in the position of beginning to exploit lunar resources.

Do any of these projections make sense, and is Wernher von Braun's analogy really valid? I don't know. Personally, I believe that the projections that I have made are somewhat conservative. I believe that the social and national imperatives that will cause us to return to the moon will turn out to be more powerful than those that caused the occupation of Antarctica. For my own part, I will do whatever I can to speed the day when people will once again put human footprints on the surface of the moon.



Independent Research & Development: DRIVE TO INNOVATE

By DR. ALLEN E. PUCKETT
Chairman and Chief Executive Officer
Hughes Aircraft Company

The strength of our nation depends in large part on the ability of our industry to create new ideas, new technologies, and new products. The ability and the drive to innovate are the cornerstones of our free enterprise system. The opportunity to compete freely in devising better ways to do things is the essence of our economic system.

These facts are especially in evidence in our defense industry, whose products are commonly at the very leading edge of modern technology. It is a highly competitive industry, and the intense pressure of that competition is a powerful force in the race to invent and produce the best and most efficient military equipment.

It is an important fact that almost none of the dramatic new technologies of this century was conceived as a result of the statement of a military requirement or the specifications in a Department of Defense contract. Consider, for example, the airplane, radar, jet engines, rocket engines, semiconductors, lasers, microcircuits, communication satellites and, of course, nuclear weapons. The conception and initial exploration of these ideas were carried out by members of our engineering and scientific community, some in academia and some in industry. They were working in an environment which allowed and stimulated novel and unorthodox thinking. They were able to make independent decisions regarding new research and development thrusts. The opportunity for many minds to work in parallel, and in competition, increased enormously the probability that truly new and useful ideas would arise.

It is also true that once DoD had perceived the potential value of these concepts, it became the strong supporter and often the leader in the development and exploitation of the inventions through its own research and development program conducted under contract with industry. This highly complementary relationship between the DoD and the defense industry is a vital factor in maintaining the technical strength of the nation, as well as insuring the strength of our military forces. It is, in fact, one of our most important secret weapons.

It is essential to understand the sharp distinction between Independent Research and Development (IR&D)—which is initiated by industry and conducted without direct contract support or obligation—and the research, development, test and evaluation (RDT&E) conducted by industry under contract to DoD and in strict accordance with a contract. The IR&D effort is the means by which industry can explore the feasibility of novel and unconventional ideas. IR&D is, therefore, the foundation for the development of the technology base and is a necessary function of any technically oriented company.

In both commercial and defense business, an investment in new technology—Independent Research and Development—is required to improve old products and to develop new ones, and thereby to stay in business. In a commercial business, company-funded R&D normally includes not only new technology but the complete cost of new product development. In the defense business, it is more customary that IR&D includes new technology and that the Defense Department will contract directly for the development of a specific product with an RDT&E contract.

In either case, the cost of IR&D is charged to an overhead account as a normal cost of doing business, just as depreciation of plant and equipment is charged. It may or may not be recovered in the price of products sold, depending on how those products were priced. It is not a direct charge or a "surcharge" against any contract.

I believe there is a commonly held misconception that the DoD agrees to "reimburse" some portion or all of the contractor's IR&D expenses. Nothing could be farther from the truth.

As a general matter, elements of a contractor's overhead are allowable to the extent they are reasonable. IR&D, however, is treated differently for larger contractors, in that a specific, negotiated ceiling amount is substituted in lieu of the more general "reasonableness" standard. Amounts spent by a contractor on IR&D up to the negotiated ceiling are allowable costs. Therefore, they are properly included in the contractor's overhead, just as other elements of overhead, such as depreciation of plant and equipment. A contractor's allowable overhead is not, however, simply charged to government contracts. Rather, it is spread over the contractor's total business, government and non-government.

IR&D ceilings negotiated are invariably less than the total IR&D expense that the contractor will incur—typically 70 to 80 percent of the contractor's proposed expenditure. This entire procedure insures that the government receives research benefits far greater than the IR&D content of the overhead allocated to government contracts.

How does this happen? Suppose a contractor does 60 percent of its business with DoD and the remaining 40 percent with non-U.S. government customers. Let's say that the contractor spends $60 million a year on IR&D, of which 85 percent is purely military-related. It would seem that the government's "fair share" would be about $50 million, or 85 percent of the cost of the IR&D in the purely defense area.

But that is not the way the system works.

First, the contractor must negotiate an advance agreement as to the ceiling amount of IR&D that the government will allow to be included in the contractor's costs. This ceiling is almost always less than the contractor actually spends. Statistics show that industry ceilings average about 75 percent of the actual costs,

so for our example, the ceiling would be $45 million.

Next, the government's cost accounting rules come into play, requiring that the ceiling be allocated to all of the contractor's government and non-government business. Since the government's share of the contractor's business is 60 percent, that is the percentage of the contractor's allowable overhead which will be allocated to the contractor's government business.

'The key to effective competition is an environment which assures the independence of contractors to exercise management authority over their IR&D efforts.'

Accordingly, the maximum amount of IR&D allocated to government business in this example would be 60 percent of $45 million, or only $27 million—despite the fact that the contractor spent $50 million on purely military-related IR&D.

This example, where a maximum of 45 percent of the value of the total IR&D done by the contractor may be allocated to government business, may seem like an exaggeration. It is not. DoD's own statistics indicate that in 1981 approximately 42 percent of the IR&D subject to ceilings was allocable to DoD contracts.

Notwithstanding the independent nature of the defense contractor's R&D program, DoD does have very extensive visibility and influence over industry-sponsored IR&D. DoD's technical influence over IR&D comes in two forms. One is the determination of "potential military relationship" of IR&D and the other is the technical quality review of IR&D programs. These reviews have teeth in them since the results directly impact IR&D dollar ceilings for cost recovery.

The DoD conducts an annual determination of potential military relationship for each IR&D project at the beginning of the company's fiscal year. IR&D costs charged to overhead relating to DoD contracts cannot exceed the expenditures for IR&D determined to have such relationship.

Technical quality review of IR&D is also performed annually by the DoD. Companies prepare annual IR&D Technical Plans, which describe in detail plans for the coming year and progress for the past year on each of their IR&D projects. Government experts evaluate the projects and develop a numerical score which is utilized by the DoD in negotiating IR&D ceilings.

DoD evaluators also provide written comments on individual projects, suggesting revised technical directions and commenting in general on the value of the IR&D project to the DoD. The company listens carefully to this advice. By means of this comment and feedback approach, DoD exerts very effective influence over the technical direction of IR&D. At the same time, participating DoD scientists and engineers greatly benefit from the technical review process by becoming better informed of the wide range of IR&D-developed technical alternatives available to the DoD.

It is not my intention to belabor the value of IR&D or the government's significant involvement in reviewing the technical content of individual contractor programs. It does, however, provide a useful background with which to examine a particular issue. Congress has singled out IR&D expense for possible "line-item" budget control because of concern expressed by the House over "visibility and accountability" of IR&D. A House report concluded, among other things, that the *total* industry IR&D expense is unknown; that IR&D costs can be charged against government contracts that the Defense Contract Audit Agency (DCAA) is not allowed to audit; and, that IR&D charges of only about 100 out of approximately 13,000 defense contractors are audited by the DCAA.

What is not made clear in the report is that no defense industry business expense, except IR&D, is subject to annual dollar ceiling requirements and, therefore, the close scrutiny that that process involves. The House report, in expressing concern over the fact that the *total* industry IR&D expense is unknown, does not make clear that well over 90 percent of those expenses *are* known and reported to Congress and the remaining few percent can be estimated within reasonable tolerances. In expressing concern over the fact that IR&D charges of only about 100 contractors are audited by DCAA, the report does not make clear that those same 100 contractors incur over 90 percent of the total industry IR&D expense.

Why should IR&D not be treated as a line item in the defense budget? In order to answer this question, it is necessary to examine the procedural results of that action.

A line item in the budget appropriates specific funds for the DoD to spend for a specific purpose. Treating IR&D as a line item would require that DoD expend those funds by specific contract commitment. The DoD would be required to apportion IR&D, contract by contract, or contractor by contractor. A contract, by its very nature, establishes a buyer-seller relationship. The "buyer" dictates the contract statement-of-work. While procedures perhaps could be conceived to implement line-item budgeting of IR&D, over a period of time, it is inevitable that IR&D contracts would assume exactly the same character as the present DoD direct contracts for R&D. The essential element of contractor decision-making would be gone. The word "Independent" would disappear from IR&D.

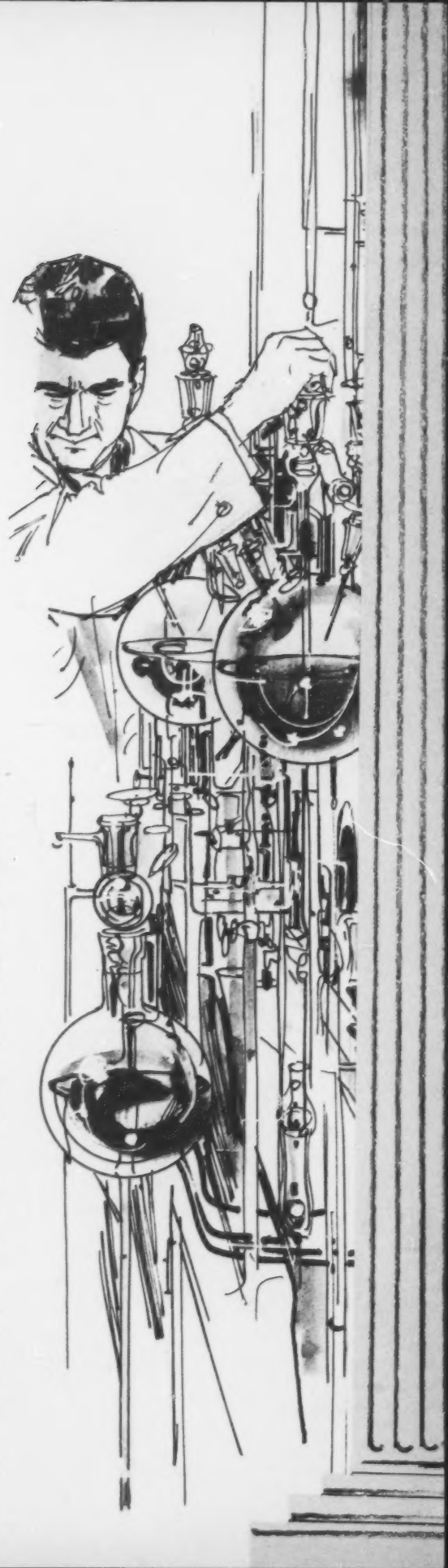
Loss of IR&D independency would drastically reduce competition. Competition in the defense industry goes far beyond the normal procedure of competitive bids on specific DoD procurements. The most important competition is at the innovative level, in an environment in which the individual contractor is free to improve existing products or to develop new ones and to communicate that product capability to the customer. The key to effective competition is an environment which assures the independence of contractors to exercise management authority over their IR&D efforts. Contracted IR&D funding will virtually guarantee the loss of contractor independence and will result in an industry environment in which effective competition cannot exist.

Thus, making IR&D a line item would destroy the very successful system of Independent Research and Development as it has evolved over the years. It would no longer be possible for contractors to reach independently into new and unexplored territory and to make decisions regarding expenditures based on independent evaluation of risk versus opportunity in a competitive environment.

'Almost none of the dramatic new technologies of this century was conceived as a result of the statement of a military requirement. . .'

It should be apparent that a very logical and workable system has evolved over the last twenty-five years for effectively limiting how much in IR&D expenses will be allocated to government business. The intelligent in-depth review of IR&D guarantees a cost-effective method for the government to achieve the scientific advances our country needs. I urge the Congress to reject the requirement for IR&D line-item budgeting, because I honestly believe that it will prove to be counterproductive and therefore will not serve the best interests of our nation.

Rx for Competitiveness—
UNIVERSITY/ INDUSTRY COOPERATION



Twenty years ago, the United States was the world's undisputed leader in technology and in manufacture of commercial products. But the American position as the preeminent industrial power has substantially eroded in the past two decades. In a number of manufacturing fields, the U.S. is being eased out of top ranking and foreign competitors are even making inroads into the area once considered the special preserve of the United States—high technology.

If the U.S. is to reverse the trend, or at least halt it, two factors appear pivotal, according to a study by the Aerospace Research Center of Aerospace Industries Association. They are a strong basic and applied research base and a pool of competent engineering manpower to apply the fruits of the research. These priorities, the study states, highlight the need to strengthen the interface between U.S. industry and the American university system, which performs most of the nation's basic research and provides the engineers.

Entitled *Meeting Technology and Manpower Needs through the Industry/ University Interface,* the study cites an "imperative need" to increase support of engineering programs to forestall a possible shortage of industrial engineers. The nation must augment university faculties, modernize research facilities at universities, and raise the quality of engineering education. It adds:

"At the national level, leaders view the quality and quantity of highly educated manpower as one of the key determinants of a nation's productivity. At the firm level, the connection with a local university is considered important enough by many executives to substantially influence decisions concerning the location of new plants and other facilities. In short, the way industry and universities work together is relevant to many of the considerations facing the U.S. economy today."

Industry support of universities—as a percentage of total academic research and development expenditures—declined over the last 20 years, while federal funding generally increased. However, in recent years federal funding has dropped off. This provides an opportunity for industry and the universities to rebuild the connection, which could speed up the process of technological innovation to the benefit of the U.S. economy's overall growth, employment growth, productivity growth and increased American competitiveness.

Over the long term, national economic and productivity growth depend heavily upon the kind of basic research provided largely at universities, the study states, adding: "The industrial history of the United States also shows that, over time, commercial use of university research is widespread and decisive. Semiconductors, lasers, synthetic fibers and antibiotics are examples of commercially

successful products developed through industry/university cooperation." Among other advantages to industry, improved interface could help executives tap more effectively the talents of university engineering faculties and identify promising students who could make a future contribution to industry.

For universities, an improved relationship with industry offers an alternative to uncertain federal funding. Closer interaction between faculty members and industry researchers could broaden the experience of university personnel and compensate for loss of university talent to industry. Most importantly, expanded cooperation could significantly improve university access to modern equipment that would otherwise be too costly to finance.

However, there are problems involved in developing greater industry/university cooperation than already exists. A big one is that university research—although it may form the *basis* for technological innovation—seldom addresses the practicalities of developing commercial products. Also, from industry's standpoint, the payback from university partnership is uncertain and too far in the future. Additionally, freedom of communication is fundamental to the university, while industry is concerned with maintaining a proprietary hold on information. These and other barriers are not insurmountable, the study feels; some can be overcome by organizational and legal devices, others by patient working out of the goals for a particular partnership venture.

In addition to industry-funded, university-conducted R&D contractual effort, there are a number of different support mechanisms that might profitably be expanded. In the industry-to-university category, there are industry-sponsored scholarships, fellowships and other graduate programs, gifts or loans of equipment, service by aerospace company staffers as adjunct professors, and service on university advisory boards by industry engineering personnel. Industry is already extensively engaged in such activities; a survey conducted as part of the study showed that, in 1981, 33 member companies of Aerospace Industries Association spent $118 million in university research and support programs.

Other mechanisms of the industry/university relationship include a number that flow in the opposite direction, from the universities to industry. Among such mechanisms are industrial associates programs, usually built around a technological field in which a university has special competence; by paying a yearly fee, participating companies receive a variety of research services related to that particular discipline. Another form of cooperation is university provision of faculty and staff as consultants to industry firms. One of the most significant developments of recent years has been the growth of university specialized centers dedicated to close industrial cooperation in specific areas of research. Examples, whose titles are self-explanatory, are the MIT-Industry Polymer Processing Program at Massachusetts Institute of Technology, which has 12 industry members, and The Center for Manufacturing Productivity and Technology Transfer at Renssalaer Polytechnic Institute, with nine industry members.

The study concludes with a series of recommendations to strengthen the industry/university interface in the interests of increased American competitiveness.

Industry should explore development of an industry-wide strategy for expanded industry/university relationships; consider establishment of aerospace research centers and projects at universities on an industry/government shared responsibility basis; and continually evaluate new ways to bring more focus to the interface.

Universities should prioritize "relevance," or industry orientation, in engineering curricula; expand problem-focused research in collaboration with industry; and increase incentives, rewards and recognition for teaching of engineering.

Federal and state governments should encourage efforts to improve national "literacy" in science and technology and, recognizing that a strengthened industry/university relationship will demand increased investment by industry, stimulate such investment by provision of tax credits and other incentives to funding of university-based R&D.

AEROSPACE INDUSTRY EXPENDITURES[a]
IN UNIVERSITIES
1981
(Millions of Dollars)

	Total Funding	Support of Engineering and Applied Science Programs
Program, faculty and student support	$ 36.9	$ 27.8
Research[b]	27.9	22.7
Acquisition of university services	20.9	12.1
Gifts	20.6	13.1
Other	11.5	8.2
	$117.8	$ 83.8

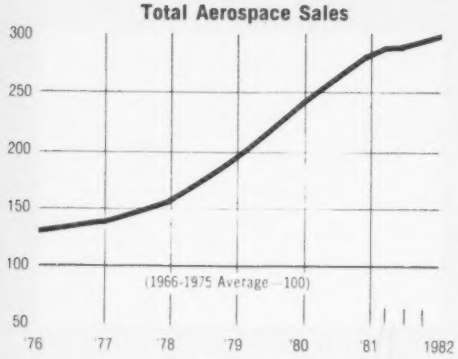
[a] Funding totals represent expenditures of 33 member companies of the Aerospace Industries Association.

[b] Includes R&D contracts, cooperative research projects, and industrial associates programs.

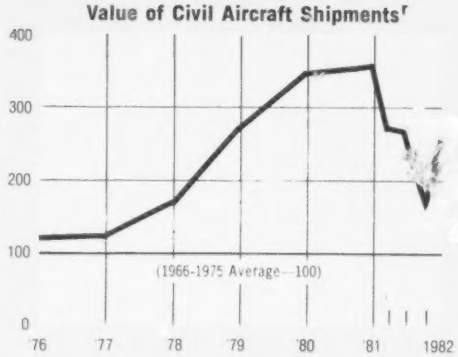
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

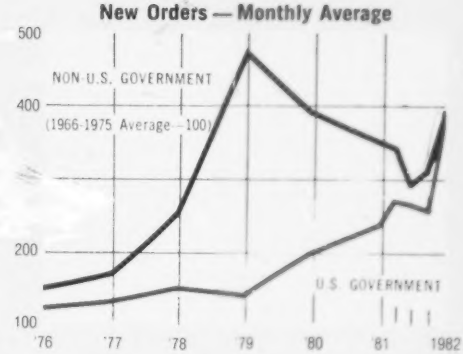


Value of Civil Aircraft Shipments[r]



OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	AVERAGE 1966-1975 *	SAME PERIOD YEAR AGO	PRECEDING PERIOD**	LATEST PERIOD 4th QTR. 1982
AEROSPACE SALES: TOTAL	Billion $	Annually***	24.2	70.0[r]	72.4	74.0
(as reported by the Bureau of the Census)	Billion $	Quarterly	6.1	18.7	18.9	20.3
AEROSPACE SALES: TOTAL	*Billion $*	*Annually****	*25.6*	*35.8[r]*	*35.4*	*35.7*
(In Constant Dollars, 1972=100)	*Billion $*	*Quarterly*	*6.4*	*9.3[r]*	*9.1*	*9.6*
AEROSPACE PRIME CONTRACT AWARDS: TOTAL	Billion $	Quarterly	5.8	18.9[r]	16.9	23.8
U.S. Government	Billion $	Quarterly	4.1	11.8[r]	10.6	16.3
Other Customers	Billion $	Quarterly	1.7	7.1[r]	6.3	7.5
BACKLOG (Major Aerospace Mfgrs): TOTAL	Billion $	Quarterly	28.6	92.6[r]	94.9	99.1
U.S. Government	Billion $	Quarterly	15.9	43.3[r]	46.0	50.5
Other Customers	Billion $	Quarterly	12.7	49.4[r]	48.9	48.6
DEPARTMENT OF DEFENSE						
Aerospace Obligations: TOTAL	Million $	Quarterly	2,712	6,244	5,727	8,850
Aircraft Procurement	Million $	Quarterly	1,986	4,915	4,354	6,604
Missiles Procurement	Million $	Quarterly	726	1,329	1,373	2,246
Aerospace Outlays: TOTAL	Million $	Quarterly	2,405	5,006	5,491	6,642
Aircraft Procurement	Million $	Quarterly	1,741	3,940	4,464	5,502
Missiles Procurement	Million $	Quarterly	664	1,066	1,027	1,140
NASA RESEARCH AND DEVELOPMENT						
Obligations	Million $	Quarterly	780	1,148	1,276	1,515
Expenditures	Million $	Quarterly	789	1,422	1,076	1,289
EXPORTS						
Total (Including Military)	Million $	Quarterly	1,038	4,344	3,372	4,151
New Commercial Transports	Million $	Quarterly	345	1,680	648	688
EMPLOYMENT: TOTAL	Thousands	End of Quarter	1,166	1,203	1,150	1,150
Aircraft	Thousands	End of Quarter	650	648	602	601
Missiles & Space	Thousands	End of Quarter	114	123	129	130
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	End of Quarter	4.38	10.91	11.36	11.77
PROFITS (after tax) BASED ON SALES						
Aerospace	Percent	Annually***	2.7	4.4	3.3	3.2
	Percent	Quarterly	2.7	3.1	3.7	2.9
All Manufacturing	Percent	Annually***	4.8	4.7	3.9	3.5
	Percent	Quarterly	4.8	4.3	3.5	2.8

*1966-1975 quarterly averages are computed as one-fourth of annual averages.
**Preceding period refers to quarter preceding latest period shown.
***Annual data are computed as the sum of the previous four quarters.
r Revised.

Source: Aerospace Industries Association

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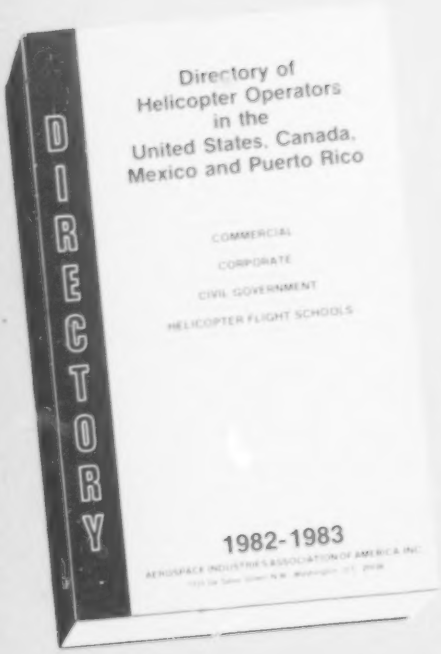

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RCA Corporation
Rockwell International Corporation
Rohr Industries, Inc.
The Singer Company
Sperry Corporation
Sundstrand Corporation
  Sundstrand Advanced Technology Group
Teledyne CAE
Textron, Inc.
  Bell Aerospace Textron
  Bell Helicopter Textron
  HR Textron Inc.
TRW Inc.
United Technologies Corporation
Vought Corporation
Western Gear Corporation
Westinghouse Electric Corp.
  Energy & Advanced Technology Group
Wyman-Gordon Company